



# AUC Undergraduate Journal of Liberal Arts & Sciences

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The Amsterdam University College (AUC) Undergraduate Journal of Liberal Arts and Sciences is a biannual, interdisciplinary publication showcasing outstanding undergraduate academic papers. The Journal aims to demonstrate the strength of undergraduate scholarship at AUC, reflect the intellectual diversity of its academic programme, and encourage the development of research and writing skills. As an AUC committee, the editorial board of InPrint strives to facilitate collaboration between students and faculty across the curriculum, and provide students with opportunities to gain experience in academic reviewing, editing and publishing.

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## Foreword

We are proud to present the 24<sup>th</sup> Volume of Amsterdam University College's *Undergraduate Journal of Liberal Arts and Sciences*!

Throughout their undergraduate studies at AUC, students write a wide range of compelling papers that usually go unnoticed beyond the context of the classroom. InPrint provides students with the opportunity to further develop these works in collaboration with an editorial team and share their work with a broader audience in the form of a research journal publication. It is a privilege to present this diverse collection of outstanding student papers. I hope you find as much enjoyment in reading them as I have in working on them alongside their talented authors and the dedicated InPrint team.

The issue begins with Lea Heitbrink's paper entitled "Tides of Change: Integrating Molecular Biology into Salt Marsh Conservation of the Wadden Sea", which evaluates current salt marsh conservation strategies and highlights the potential of molecular biological techniques in addressing the dynamic needs of the Wadden Sea ecosystems. Second in the Sciences section is a paper by Jorge Gonzales Larragoiti, "High-Order Neuroscience: Synergy Between Mathematics and the Brain", in which he discusses the potential applications of high-order mathematical frameworks in neuroscience and how their use could address the limitations of traditional pairwise models in the field.

Opening the Social Sciences section is "Ecocide in Gaza? A Comparative Analysis of Three Legal Frameworks in International Humanitarian Law for the Prosecution of Environmental Destruction by Israel in the Gaza Strip", in which Ryan Kruijt performs a comparative legal analysis of three definitions of environmental destruction to examine the limitations of current legal frameworks in addressing the Israeli-caused environmental degradation in the Gaza Strip. Next, Erika Vodvárková, in her paper "The Little Brother's Revolt: The Role of National Identity in Slovakia's Autocratic Turn" explores how key moments in the history of Slovakia and the Czech Republic have shaped their distinct contemporary political landscapes.

In the Humanities section, in "Layers of Resistance: Protest Stickers and the Participatory (Counter-)Memory of Urban Space," Małgorzata Czachowska examines how protest stickers constitute a transient, yet powerful tool of civic engagement, transforming urban spaces into dynamic sites of collective memory. Finally, in "'I'm in a grave situation': Stone and Deathscapes" Polina Smirnova discusses how the dynamics of distinction, exclusion, and care play out through stone as a grave marker material in the context of the history of grave marker materiality as well as the relation between wood and stone within the grave of her grandparents.

Closing this issue is Nayonika Venkatesh's paper, "Constructing a Cognitive Model for Context-sensitive Processing of Movies", which reviews the research in neurocinematics — a novel field at the intersection of neuroscience and film studies exploring how film is processed in the brain. Based on the developments in this field, it proposes a preliminary cognitive model of context-sensitive processing.

To conclude this foreword, I would like to deeply thank everyone who made the publication of this issue possible. I would like to extend my gratitude to the InPrint Head Editors, Lena, Malavika, Julia, and Zuzia, for their consistent support and guidance extended not only to their respective departments, but also to me. Thank you to all the editors who have remained at InPrint through several iterations of the publication process — Éléna, Elena F., Elena V., Fatima, Kia, Natalie, Mariin, Sara-Lina, and Wilma, as well as the editors who joined InPrint this semester — Bahar, Cecile, Lucille, Nikoleta, and Omer. Without your insight, enthusiasm, and dependability, publication would be impossible. I am also deeply grateful to the sensitivity readers — Dr. Rébecca Franco, Samareen Sharook Hussain, and Dr. Misha Velthuis, as well as the students who peer reviewed the papers during the final editing stages. I'd also like to thank InPrint's Faculty Advisors, Luis and Joost, for their advice and help in developing InPrint as a part of the AUC community. I also want to thank Polina, the previous Editor-in-Chief, for preparing me for this publication process and reassuring me throughout it. Lastly, I'd like to thank Misia Loch and Alice Humphreys for their unwavering support and care.

*Basia Haber, Editor-in-Chief*

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Tides of Change: Integrating Molecular Biology into Salt Marsh  
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Lea P. Heitbrink



*Salt marsh near Groningen. Photograph by the author (2024).*

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## Abstract

The Wadden Sea, recognized as a UNESCO World Heritage site, is a haven of biodiversity increasingly threatened by climate change and rising sea levels. Current management strategies, including grazing, groins, drainage system maintenance, and sediment nourishment, have largely been inherited from mid-20<sup>th</sup> century agricultural practices, despite a shift toward nature conservation. These strategies, such as livestock grazing and sea-ward expansion of salt marshes, spark debates regarding their effects on biodiversity and ecosystem health. Furthermore, human-made barriers, such as dikes, prevent salt marshes from adapting naturally to sea-level rise. In response, this review examines how molecular biology can provide new insights into salt marsh health. Techniques such as microbial community analysis and genetic monitoring are identified as potential tools for assessing ecosystem health, offering a more holistic approach to conservation. By integrating molecular biological methods, conservation strategies could be better adapted to the changing needs of the salt marsh ecosystems of the Wadden Sea.

Keywords and phrases: *Wadden Sea, Salt marsh, Conservation, Molecular biology*

## Introduction

As climate change and rising sea levels continue to impact ecosystems globally, intertidal zones — which are submerged during high tide but exposed during low tide — have been left particularly vulnerable (Reise, 2005). The Wadden Sea, the world's largest intertidal system and a UNESCO World Heritage site (UNESCO), spans the North Sea coasts of the Netherlands, Germany, and Denmark. Numerous conservation initiatives, such as the "Trilateral Wadden Sea Cooperation" (TWSC), have been established to protect the vast tidal flats, salt marshes and the unique ecosystem that they support. However, human made dikes and agricultural use hinder the natural adaptation of salt marshes to the effects of climate change, which leads to coastal shrinking and threatens this ecosystem (Reise, 2005). Eden and Thorenz (2024) review current strategies to manage the salt marshes of the Wadden Sea, including grazing, maintenance of drainage systems, sediment nourishment, and groins – wooden structures built perpendicular to the shoreline to reduce wave friction and prevent sediment movement. Though the goal of these management strategies has shifted to conservation since their development for agricultural exploitation in the mid 20<sup>th</sup> century (Esselink et al., 2017; Reise, 2005), the employed methods have stayed mostly the same. There is contradicting evidence on whether measures like grazing and drainage system maintenance contribute to nature conservation. Thus, there is a need to investigate potential indica-

tors of salt marsh health to assess current conservation strategies, adapt them where needed, and possibly develop new ones. Traylor-Knowles and Palumbi (2014) and Rodríguez-Martínez et al. (2022) suggest that molecular biological techniques, such as the analysis of microbial communities, can inform and guide conservation efforts around the world. Considering this new perspective on conservation measures, how are microbiological tools currently incorporated into salt marsh conservation and what is their potential going forward? This review assesses the current salt marsh conservation methods and identifies challenges they face. It continues to investigate the role of molecular biological tools, such as genome analysis and modification in salt marsh conservation in the Wadden Sea and defines their potential to address the challenges with current conservation efforts and possibly develop new ones.

## Current state of conservation strategies in salt marshes

The Wadden Sea is located in the northern regions of Germany, the Netherlands, and Denmark and has a long history of human exploitation. On the seaward side, a group of islands, the barrier islands, separates it from the open ocean (Fig. 1). Between these islands and the mainland lie mudflats, which are exposed to air during low tide and submerged during high tide (Reise, 2005). Salt marshes develop in the higher, more landward parts of the intertidal zone (Eden and

Thorenz, 2024). These marshes are found both on the mainland and on the mainland-facing sides of the barrier islands and differ from each other, for example in soil composition (Eden and Thorenz, 2024). While many barrier island salt marshes have experienced only minor human interference, mainland marshes have been heavily shaped by human activity (Eden and Thorenz, 2024). Reise identifies, for instance, that the naturally curved and dynamic creeks of barrier island marshes are replaced with straight, grid-like drainage systems in most salt marshes on the mainland indicating human activity. Additionally, most mainland marshes are not considered natural, as they were artificially created and then drained for agricultural purposes, such as livestock grazing and crop cultivation (Reise, 2005).



Figure 1: Map of the Wadden Sea area. Image taken from Eden and Thorenz (2024)

Many measures aim to protect salt marshes, but these approaches have not changed significantly over time. The ecological importance of salt marshes has been recognized since the 1930s, which has resulted in a shift from agricultural exploitation to nature conservation (Reise, 2005). Grazing is a widely used management practice in which horses, sheep, or cows graze predominantly in the higher areas of the marsh, significantly reducing the height of the vegetation (Eden and Thorenz, 2024). Eden and Thorenz (2024) suggest that grazing can have both posi-

tive and negative effects on plant biodiversity, depending on factors such as the type of livestock, grazing density, and the specific location within the marsh. Drainage systems, which historically consisted of grid-like ditches used to remove water for agriculture, are now largely abandoned. However, according to Esselink et al. (2014) these systems are occasionally maintained to harden the ground for livestock grazing. Groins aim to reduce wave energy and thus protect the salt marsh from erosion. Together with sediment nourishment — the placement of sediment near existing salt marshes to increase their elevation — groins are used to artificially expand marshes seaward (Eden and Thorenz, 2024). Although the primary goal of salt marsh management has shifted toward nature conservation, the techniques described by Eden and Thorenz (2024) are similar to those that Reise (2005) identified as being historically used for agricultural exploitation. Outdated measures might not be able to address emerging challenges.

The salt marshes of the Wadden Sea face ongoing threats from sea-level rise, such as habitat loss despite conservation efforts. Reise (2005) describes how, under natural conditions, salt marshes adapt to rising sea levels by migrating landward. However, human-made dikes prevent mainland marshes from doing so, leading to coastal shrinkage (Reise, 2005). Although there is a clear intention to conserve the natural landscapes of salt marshes and various conservation measures are in place, these ecosystems remain at significant risk of disappearing due to rising sea levels and coastal protection measurements that interfere with their natural adaptive mechanisms.

## Challenges with current conservation strategies

Current conservation efforts of salt marshes in the Wadden Sea area are facing challenges, including outdated management strategies. Many existing interventions, such as groins, drainage systems, and sediment nourishment, primarily aim to maintain or expand salt marsh areas (Eden and Thorenz, 2024). Conservation strategies targeting vegetation similarly focus on salt marsh expansion (Baptist et al., 2019). However, these goals are rooted in historical objectives, origi-

nally aimed at reclaiming salt marshes for agricultural exploitation (Reise, 2005). Current practices appear to prioritize seaward expansion, often through sediment nourishment or reducing wave energy with groins. Even though the salt marsh ecosystem does need to grow to be partially above water, these approaches overlook the natural landward growth of salt marshes which naturally would allow them to adjust to changing sea levels (Reise, 2005).

The effectiveness of other strategies, such as grazing and the maintenance of the drainage systems, is under debate (Eden and Thorenz, 2024; Esselink et al., 2014). On the one hand, Ford et al. (2013) and van Klink et al. (2016) suggest that grazing leads to an increase of plant biodiversity. Esselink et al. (2017) further state that grazed areas of salt marshes are beneficial for some migratory birds. On the other hand, Keshat et al. (2020) disagree and refer to a higher biodiversity in ungrazed salt marshes compared to the ones managed by livestock grazing. Wanner et al. (2014) also argue that an increase in biodiversity depends on the area size examined and suggest that a reduction in grazing can lead to increased biodiversity. The maintenance of the drainage system has been discontinued in the Netherlands and Germany since the late 20<sup>th</sup> century (Eden and Thorenz, 2024) to allow the development of natural tidal creeks. It is, however, still partially utilized by farmers in the Netherlands to drain the soil and therefore harden it to allow livestock grazing (Esselink et al., 2017). Considering the debate on whether grazing has a favorable or unfavorable impact on the ecosystem, the continuation of the maintenance of drainage systems exists in a gray area between agricultural exploitation and nature conservation.

Furthermore, a decentralized approach to conservation poses a challenge. While Haan et al. (2014) defended the decentralization of the Dutch Wadden Sea because policies can be tailored to the respected area, they also provide case studies when decentralization has led to problems such as poor communication and lack of action.

## Potential role of molecular biology in conservation strategies

Current management strategies are not up to date with the advances in molecular biological techniques which can be utilized as bioindicators to positively contribute to conservation efforts. Biological indicators (bioindicators), which are living organisms that react sensitively to changes in the environment such as pollution and drought, are a valuable tool to assess ecosystem health (Holt & Miller, 2010). Rodriguez-Martinez et al. (2022) criticize the absence of molecular biological strategies in conservation efforts and refer to the outcome of a workshop hosted by the European Molecular Biology Laboratory to define three potential targets for molecular biological approaches: the food and chemical sector, food and agriculture, and ecosystems modulation. Ecosystem modulation is the most relevant in the context of Wadden Sea conservation as it suggests the use of bioindicators to assess ecosystem health and indicate the approaching of possible tipping points. Traylor-Knowles and Palumbi (2014) also argue for the use of molecular biology to create bioindicators which can give valuable insight into ecosystem health. They refer to a study by Barshis et al. (2013) who utilize molecular biological techniques such as mRNA sequencing and gene expression analysis to assess the stress response of corals to heat. Traylor-Knowles and Palumbi (2014) argue that these approaches can be used to create molecular indicators that can influence environmental policies to protect endangered species. Environmental factors such as nutrient availability, soil pH and salinity determine which species of soil microbes can thrive in a specific ecosystem. If these factors change, so does the composition of microbial communities (Rinke et al., 2022). Species of microbes can be identified by analyzing their genome, which reflects the adaptation to environmental factors, with various techniques and insight into their composition could be used to inform conservation efforts. Techniques such as mRNA sequencing and gene expression analysis are widely used methods and can therefore be easily incorporated to fit necessary research in the Wadden Sea.

Molecular biological techniques provide valuable genetic insight which can be used for systematic conservation planning (SCP) and can further-

more function as new conservation approaches. Nielsen et al. (2023) describe how molecular ecology can improve SCP by using data obtained from molecular biological analysis of ecosystems. They refer to a study by Rosauer et al. (2017) which highlights the importance of conserving phylogenetic diversity, which takes the evolution of a species into consideration by analyzing their branch length on the tree of life. In conservation, integrating the phylogenetic diversity would allow to prioritize the protection of species that are able to adapt well to a changing environment based on their evolutionary history (Rosauer et al., 2017). Nielsen et al. (2023) argue that utilizing molecular ecological insights such as phylogenetic diversity for SCP allows limited conservation resources to be spent most efficiently. Though Rosauer et al. (2017) refer to the mammalian tree of life, the concept of the importance of phylogenetic diversity could be adapted and used to determine which plant species of the salt marsh area are most genetically valuable and should be prioritized in conservation efforts. Rather than only providing insight into organisms genetics, Rodriguez-Martinez et al. (2022) argue that molecular techniques can be used to genetically modify plants on land or phytoplankton in the oceans to enhance carbon sequestration and thus mitigate global warming. Analyses of microbial genomes and the potential to modify them show how molecular biological techniques can and have been utilized to inform and enhance conservation strategies.

Although literature highlights the potential of molecular techniques in conservation, current approaches largely exclude molecular biology, both as a tool to inform conservation efforts and as a direct approach. For example, Wanner et al. (2014) assess the success of grazing and biodiversity by analyzing vegetation data from plots, which involves strategically dividing a region and counting plant species. Similarly, Van Klink et al. (2016) use aerial photographs to identify plant species and compile them into vegetation maps. To evaluate the effectiveness of groins and sediment nourishment, Baptist et al. (2019) measure sediment height and quantity. They also examine vegetation type and density using a combination of historical aerial imagery and recent UAV orthophotos (Baptist et al., 2019). All of these methods do not include molecular biological techniques for determining success and assessing ecosystem health.

They rely heavily on plant identification and overlook other critical components of the ecosystem, such as microbial communities. These communities, which are not observable through cameras or the human eye, require molecular biological techniques for proper analysis and understanding.

## **Molecular biology as strategy for salt marsh conservation**

Molecular biological techniques can be used to identify and define biological indicators, such as microbial communities in the soil. Soil microbes inhabit ecological niches based on many abiotic factors such as nutrient and oxygen availability as well as moisture (Hoorman, 2016) Rinke et al. (2022) utilize phospholipid fatty acid (PLFA) analysis to examine the spatial and temporal distribution of microorganisms. While the implications of their results aren't discussed in the context of conservation, these methods could, for instance, be used to assess microorganisms as bioindicators of biodiversity, helping to resolve debates over grazing. They could also potentially provide further insight into the effects of sediment nourishment and groins. The relevance of microorganisms as bioindicators is supported by the study conducted by Buckley and Schmidt (2001), who used quantitative rRNA probing and 16S rDNA T-RFLP to investigate differences in the microbial structures of cultivated and uncultivated fields. They found that the composition of the microbial community differed significantly depending on whether the soil had been cultivated for agricultural use. Even after 7 years of no cultivation, the microbial community had not returned to pre-cultivation levels, demonstrating how microorganisms can serve as valuable bioindicators of ecosystem health (Buckley and Schmidt, 2001). In addition, Gupta et al. (2020) suggest that the genetic analysis of parasites through DNA sequencing could also function as a bioindicator for ecosystem health. By analyzing the microbial community composition of natural salt marshes and examining parasites, these factors could provide additional indicators of salt marsh health, complementing traditional measures such as salt marsh size and vegetation.

Moreover, to determine bioindicators, insights gained through molecular biological analysis of the microenvironment can lead to new, molecu-

lar biology-based approaches to conservation. Microbial communities vary not only based on the flora and fauna composition of their environment, but also provide essential nutrients to the soil by decomposing dead organic material, thereby influencing their surroundings (Semenov and Đukić, 2020). Gaining more insight into the relationship between specific microbial communities and plant species in salt marshes could be crucial in addressing the negative effects of anthropogenic changes, such as the remnants of drainage systems. Furthermore, genetic engineering, which involves strategically modifying DNA to express desired traits, is already being used to increase crop resilience against various diseases and has the potential to also enhance conservation efforts (Chaurasia et al., 2020; KWS, 2023). Genetically modifying plants and organisms in the salt marshes could enhance their resilience to ecosystem changes resulting from sea-level rise and other environmental stressors.

While the integration of molecular biology into salt marsh conservation appears necessary to inform and enhance current measures, Nielsen et al. (2023) highlight that there are limitations to consider. Incorporating molecular biology into conservation practices may require additional time and resources to collect and analyze data, potentially delaying the implementation of conservation actions.

## Conclusion

Although there has been a much-needed shift from agricultural exploitation to nature conservation in the salt marshes of the Wadden Sea, the measures used to ensure conservation are strikingly similar to those originally employed for agricultural purposes. The uncertain positive effects of grazing and seaward salt marsh expansion further highlight the urgency of developing innovative strategies to enhance conservation efforts. Molecular biology offers significant potential to inform conservation through the identification of biomarkers and as a tool to address challenges, such as by altering microbial communities. However, when planning the integration of molecular biology into conservation practices, it is important to account for limitations such as time constraints and resource availability. In the future,

the insights gained from this literature could be applied to initiate field trials, using molecular biological techniques to inform and develop new conservation measures. Over the long term, these advancements could lead to conservation strategies that are better adapted to the specific needs of salt marshes, ensuring their resilience and continued existence in the face of rising sea levels. Implementing such changes, however, can also lead to tension with local farmers as conservation strategies that are backed up by molecular biological techniques, for example decreasing life stock grazing, possibly interfere with current agricultural practices. To create a sustainable co-existence between humans and the salt marsh ecosystem in the future, this discussion has to extend beyond the sciences into a sociopolitical realm.

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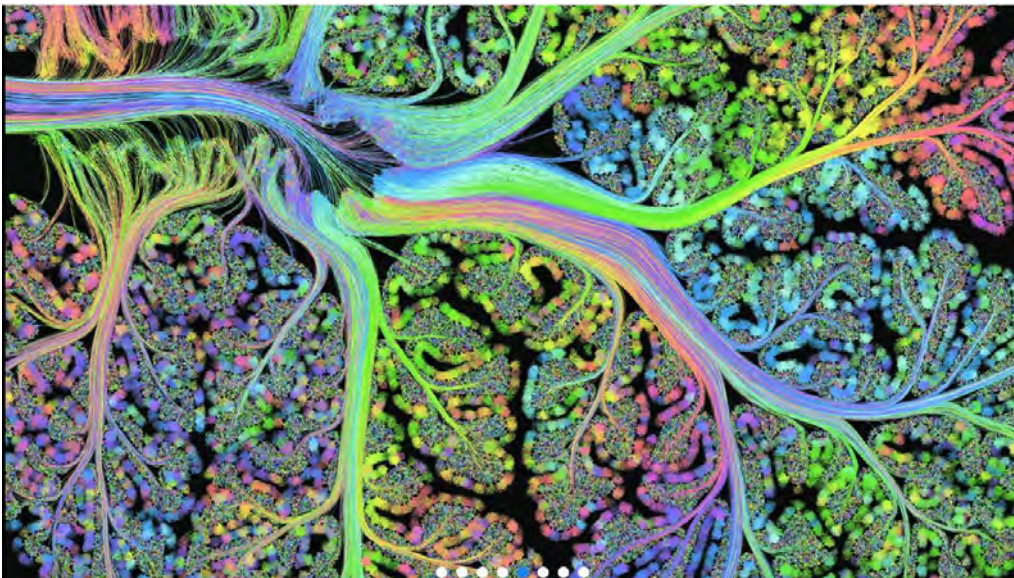
Sciences

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## High-Order Neuroscience: Synergy Between Mathematics and the Brain

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Jorge Gonzalez Larragoiti



*Self Reflected (detail)*. Greg Dunn and Brian Edwards (2014-2016).

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## Abstract

This review examines advancements in high-order mathematical frameworks and their transformative applications in neuroscience, highlighting their potential to address the limitations of traditional pairwise models. While pairwise models fail to capture the multifaceted interactions of brain regions, limiting their ability to holistically represent brain dynamics, higher-order frameworks provide innovative approaches to model and analyse the brain's complexity. The review first introduces two model-based frameworks — namely, hypergraphs and simplicial complexes. Hypergraphs, a direct high-order generalization of graph theory, enables the flexible representation of multivariate interactions. Whereas simplicial complexes, an algebraic topology framework, offer a robust approach to study brain architecture using techniques like persistent homology. Conversely, information theory, a model-free framework, is discussed as a recent development for quantifying integration and segregation in brain networks. By employing concepts of redundancy and synergy, information theory offers novel insights into neural dynamics and multivariate interactions. This paper also highlights key applications, such as uncovering emergent brain dynamics, and supporting clinical advances in brain function analysis and the diagnosis of neurodegenerative disorders. These findings underscore the urgent need for neuroscience to transition from traditional pairwise methods to high-order frameworks, laying the foundation for innovative interdisciplinary research.

Keywords and phrases: *High-order interactions, Brain dynamics, Computational topology, Information theory in neuroscience, Neural complexity*

## Introduction

The human brain is a highly complex system composed of about 86 billion neurons with more than 100 trillion connections from which self-awareness, memory and directed behaviour emerge (Yu et al., 2011). Traditional approaches to studying brain connectivity have primarily focused on pairwise interactions between regions, often using graph theory — a branch of mathematics that models pairwise relationships through structures called graphs — to map and analyse these connections (Lord et al., 2016). While these methods have yielded significant insights, they are inherently limited in their ability to capture the full complexity of brain networks (Battiston et al., 2020). These limitations underscore the need for advanced frameworks able to capture multivariate interactions, a challenge made more approachable by the development of computational neuroscience and its technological counterparts.

This increase in computational power has enabled the development of diverse frameworks facilitating the study of more complex systems, offering promising avenues to overcome the limitations of graph theory. One such modelling framework applies computational topology techniques to construct high-order connectivity models. Unlike pairwise approaches, simplicial complexes

and hypergraphs consider the simultaneous interactions among three or more brain regions (Battiston et al., 2020; Giusti et al., 2016). Together, these topological models provide a more accurate and comprehensive representation of the brain's functional architecture, revealing patterns of connectivity that are not apparent in traditional network pair-based models (Battiston et al., 2020). Information theory, another transformative theoretical framework in neuroscience, evaluates how much information one variable conveys about another (Rosas et al., 2019; Shannon, 1948; Timme & Lapish, 2018). Because this approach is model free and naturally multivariate it allows a wide range of interactions and phenomena to be quantified, without having to know the underlying rules governing the system under research (Timme & Lapish, 2018). Using entropy-based metrics, information theory uncovers complex system-level phenomena that are invisible when studying individual components of the brain (Rosas et al., 2019). This feature results particularly useful when considering the incredibly dense network connectivity that leads to synergistic interactions between different regions. These frameworks complement each other in capturing the multifaceted nature of brain networks, providing a transformative lens to understand brain dynamics and overcome the limitations of traditional

pairwise approaches. This review synthesizes recent developments in model-based and model-free high-order frameworks in neuroscience, with the goal of clarifying their individual strengths, limitations and potential for integration. By examining hypergraphs, simplicial complexes, and information theory, it highlights how each contributes uniquely to the understanding of multivariate brain interactions — and how, together, they address key limitations in traditional pairwise approaches.

## Model Based Frameworks

### Graph Neuroscience

Graph theory represents one of the most broadly used frameworks for modelling connectivity in complex systems, including brain networks (Giusti et al., 2016; Lord et al., 2016; Sizemore et al., 2018). In mathematics, a graph  $G$  is composed of a set of vertices  $V$  and edges  $E$  (Petri et al., 2014). When applied to the brain, a vertex  $v$  can represent a wide range of anatomical structures, from individual neurons to large, interconnected networks (Giusti et al., 2016). The choice of what a vertex represents depends on the system being analysed, providing researchers with flexibility in modelling neural structures. For example, in studies of synaptic interactions, vertices may represent neurons and edges the synapses between them. In contrast, studies of larger cortical structures might define vertices as brain regions and edges as correlations in their activity (Giusti et al., 2016). Graphs thus provide a powerful tool for abstracting the dyadic connections in neural dynamics.

The development of multivariate measurement techniques, such as functional magnetic resonance (fMRI) and electroencephalogram (EEG), has further enabled researchers to capture activity across several brain regions simultaneously (Herzog et al., 2022). Graph theory has been an essential framework for modelling these interactions, particularly through the concept of functional connectivity. Functional connectivity represents the correlation in activity between two regions and is measured using statistical techniques like the Pearson correlation, a linear correlation between pairs of simultaneously measured time series (Fornito et al., 2016; Rosas et al.,



Structural brain network

Figure 1: Application of a graph to model structural connectivity of a brain network

2019). Research projects such as the Human Connectome Project have employed these methods to create detailed maps of the brain's structural and functional architecture. These insights have laid a foundation for understanding neural dynamics and have driven preliminary advancements in neuroscience research, such as the establishment of the relation between the anatomical structure of the brain and its functional counterpart (Glasser et al., 2016).

Despite its contributions to neuroscience research, graph theory has inherent limitations, particularly in its ability to fully model the complexity of brain connectivity (Herzog et al., 2022). Since it focuses solely on pairwise interactions, models based on it rely on bivariate metrics such as motifs (recurring patterns of connectivity) and transitivity coefficients (likelihood of interconnectedness among nodes) (Battinson et al., 2020). While these metrics can fully describe dyadic relationships, they fail to capture the simultaneous, multivariate interactions that occur among three or more nodes, which are critical for understanding the complex mix of dynamic interactions between neurons, neural groups and larger functional hubs (Plis et al., 2013; Varley et al., 2023). Consequently, these models offer only an incomplete representation of the brain's interconnected dynamics, highlighting the necessity for high-order

frameworks (Lord et al., 2016).

## Hypergraph Neuroscience

In contrast to graphs, hypergraphs, defined as a set of  $V$  nodes and a set of  $H$  hyperedges, provide an unconstrained description of high-order  $k$ -interactions (Battinson et al., 2020). A  $k$ -interaction involves  $k+1$  nodes, with  $k \geq 2$  classified as high-order interactions that extend beyond pairwise relationships (Battinson et al., 2020). More intuitively, an edge in a graph is geometrically represented by a line joining two nodes, while a hyperedge is a higher dimensional object (e.g. a plane) joining more than two nodes. For instance, a hyperedge might represent the coordinated activity of a neural triad involved in a cognitive task, capturing interactions among three brain regions simultaneously. Hypergraph-based models of the brain have allowed researchers to analyse how several brain regions interact, adapt, and integrate information during cognitive processes, and provide new insights on the organization and functionality of neural networks (Pisarchik et al., 2024). These advantages make hypergraphs particularly suited to modelling the intricate multivariate relationships in neural networks, offering a level of accuracy not achievable with traditional graph models.

While hypergraphs offer clear advantages over traditional graph models, researchers face significant challenges in applying them to neuroscience. A major constraint of hypergraph models is the "combinatorial explosion," where the computational demands for analysing interactions grow rapidly, even in relatively small systems (Giusti et al., 2016). Additionally, extending graph-theoretic concepts, such as Laplacian operators, to their higher-dimensional counterparts introduces mathematical complexities that are difficult to resolve analytically and require significant computational power to be applied numerically (Battinson et al., 2020). Hypergraphs offer unparalleled flexibility in modelling high-order interactions, but their computational complexity underscores the need for alternative frameworks in neuroscience research.

## Algebraic Topology Neuroscience

Simplicial complexes can be thought of as an algebraically equipped extension of hypergraphs (Battinson et al., 2020; Giusti et al., 2016). Simplices, the building blocks of simplicial complexes, are topological structures that connect multiple nodes, overcoming the restrictive pairwise representations (Battinson et al., 2020; Petri et al., 2014; Sizemore et al., 2018). A  $k$ -simplex is formed by  $k+1$  nodes. For example, a 0-simplex represents a single node, while a 1-simplex represents two nodes joined by an edge. One of the main differences between simplices and hypergraphs arises when introducing the 2-simplex, which is represented by three nodes, each joined by edges to their adjacent neighbour and by a triangular hyperedge as a triplet. Because of their algebraic definition, simplices must always include all their lower-dimensional components, called sub-simplices (Battinson et al., 2020). For example, a 2-simplex, represented as a triangle connecting three nodes, must also include the three edges (1-simplices) connecting each pair of nodes and the three individual nodes (0-simplices). In contrast, a triangular hypergraph does not require all pairwise connections between nodes to be explicitly included, allowing for more flexibility but less structured representation (Battinson et al., 2020). While this constraint limits the representational ability of simplicial complexes, it facilitates their analysis through algebraic topology (Battinson et al., 2020). Since nodes in simplicial complexes can be considered as points in a topological space and algebraic topology concerns itself with the shape and properties of this space, this branch of mathematics provides a language to study higher-order interactions (Sizemore et al., 2018).

Curto and Itskov (2008) first used simplicial complexes to model hippocampal place cells, showcasing their ability to capture topological relationships in neural activity beyond the reach of traditional graph models. In their research, they were able to reveal the structure of stimulus space by modeling the relationships between groups of cofiring neurons, demonstrating that an animal's position in an environment can be purely derived from action potentials of neurons in the hippocampus. Since then, these structures have become an extremely valuable tool to analyse

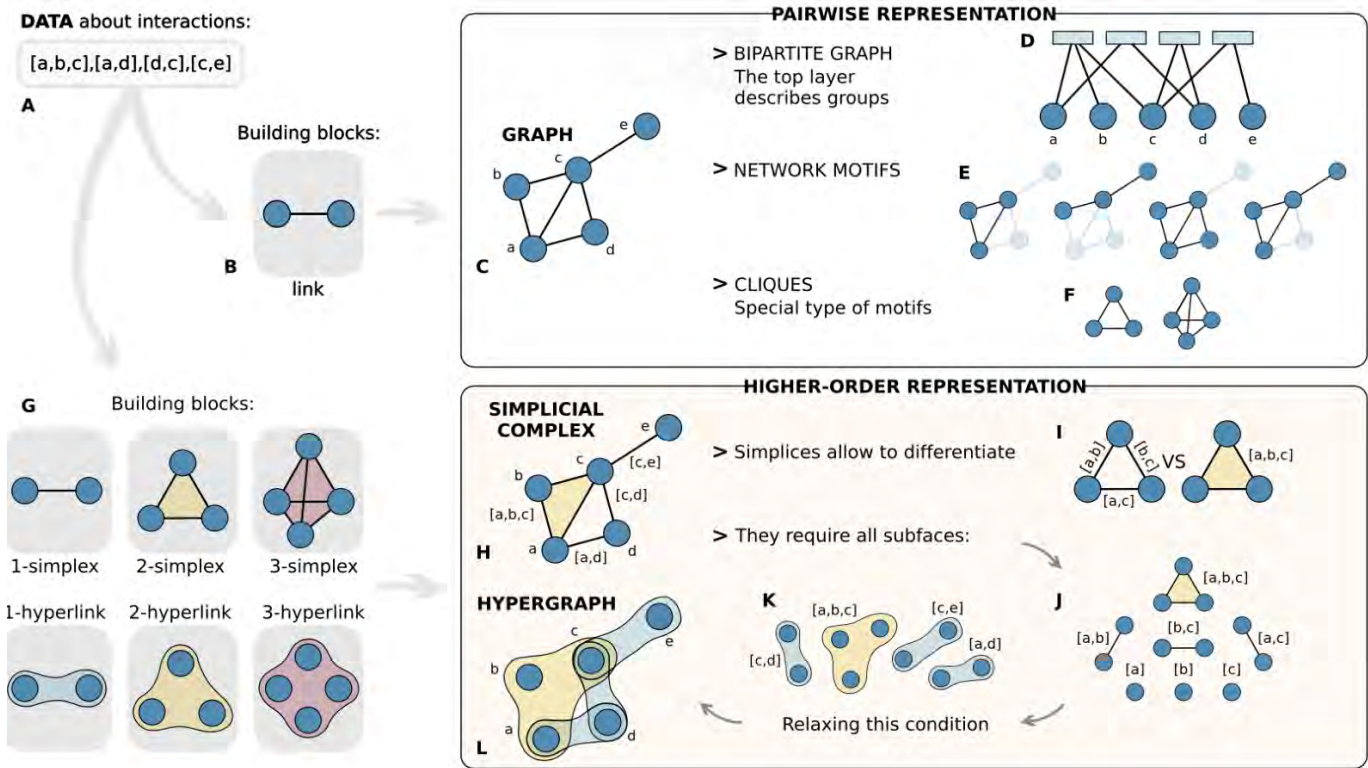


Figure 2: Pairwise vs. High Order Representation

high-order brain datasets using topological techniques such as simplicial homology (Sizemore et al., 2018). Simplicial homology is a computational topology technique well suited to analyse high-dimensional datasets (Lord et al., 2016). This technique provides insights into where and when lower connectivity regions emerge in simplicial networks through filtration; this process systematically adds simplices to analyse evolving connectivity patterns by observing the persistence of topological holes (Petri et al., 2014). Based on this filtration process, a persistence homological scaffold can be constructed as a summary network that provides significantly more information than traditional pairwise methods about the structure of the neuroimaging functional data (Lord et al., 2016). This approach moves beyond dyadic associations, offering a framework for analysing the distributed, high-order relationships central to brain function. Furthermore, the scaffold can describe relations between clusters of networks, which are consistent with the brain’s modular encoding of information (Lord et al., 2016). Petri et al. (2014) showed a practical application of simplicial homology to analyse fMRI data from people under the effects of psilocybin. From this anal-

ysis, they concluded that psilocybin disrupts the brain’s normal organization, leading to the emergence of strong, topologically long-range functional connections absent in a typical state (Petri et al. 2014). This practical application displays the analytical power of computational topology to detect changes in modularity in brain networks.

Algebraic topology, the branch of mathematics describing simplicial complexes and holes, has become an insightful analysis framework to describe high-order connectivity and network properties in neuroscience (Santos et al., 2019). Despite its limitations, such as parameter selection or noisy data, present challenges, they are less restrictive when modelling complex interactions than the inherent pairwise constraints of graph theory or the computational demands of hypergraphs (Battinson et al., 2020). Ultimately, algebraic topology provides a powerful alternative to graph-based frameworks, offering a more holistic approach to studying the brain’s complexity through high-order analysis.

## Model-Free Frameworks

### Introduction to Information Theory in Neuroscience

Established in the mid-20th century, information theory defines information in a system as the average data an observer gains through measurement (Rosas et al., 2019). The possible amount of information contained in a system is related to its entropy, a concept quantifying the uncertainty or possible states of a variable prior to measurement (Timme & Lapish, 2018). Mathematically speaking, Shannon's entropy, one of the fundamental equations in information theory, is defined as

$$H(X) = \sum_{x \in X} p(x) \log_2 \left( \frac{1}{p(x)} \right)$$

, where  $p(x)$  is the probability of a variable being in state  $x$  (Shannon, 1948). To understand Shannon's entropy, consider two people, Anna and Bob, doing a coin flip. Bob flips the coin and observes the outcome, while Anna is unaware of it. Before Bob reveals the result, Anna faces uncertainty — there are two possibilities, heads or tails. When Bob reveals the result to Anna, he provides information that reduces her uncertainty (entropy). In neuroscience, this concept is applied to measure how much information a neural signal conveys about a stimulus with, according to the aforementioned metaphor, the result of the coin flip being the latter and Bob's confirmation the former. (Timme & Lapish, 2018). The application of Shannon's entropy forms the basis for quantifying information exchange in brain networks and serves as the foundation of information theory (Plis et al., 2013).

Building on this foundation, partial information decomposition (PID) extends the framework by analysing how multiple predictors contribute to information about a single variable, distinguishing between redundancy and synergy (Rosas et al., 2019). Redundancy quantifies shared information between variables, while synergy captures how the whole system conveys more information than its individual components (Timme & Lapish, 2018; Varley et al., 2023). PID builds upon one of the most fundamental ideas in modern theoretical neuroscience, which poses that the human brain maintains a balance between synergistic and redundant interactions (Varley et al., 2023).

Through both of these interactions, the brain is able to maintain an integration-segregation balance principle combining specialized regional functions with overall system-wide coordination (Varley et al., 2023). Synergistic brain functions, which can only be explained by analysing the integration of multiple neural structures, highlight the essential role of high-order frameworks like PID (Rosas et al., 2019). Although PID offers a promising approach for analysing high-order brain interdependencies, its adoption is limited by the need to partition systems into sources and targets, restricting holistic analysis, and by the challenge of selecting a redundancy function, which can significantly alter results depending on the arbitrary choice (Varley et al., 2023). Despite its ability to capture redundant and synergistic interactions, PID remains difficult to apply effectively to brain networks.

From this notion, Rosas et al. (2019) developed O-information, a symmetric measure quantifying the balance between redundancy and synergy in multivariate systems. Negative O-information indicates the predominance of synergistic interactions, while positive indicates predominant redundant interactions (Varley et al., 2023). This quantity provides an estimate of the dominance of synergy or redundancy in a system, overcoming all the limitations of PID by eliminating the need for partitioning systems into sources and targets and avoiding the ad hoc redundancy function choices associated with PID (Rosas et al., 2019; Varley et al., 2023). By using O-information, Varley (2023), was able to conclude that synergy is a widespread property of multivariate information emerging from brain activity. Hence, O-information highlights the synergistic nature of brain activity, reinforcing the need for high-order methods in neuroscience.

Information theory offers key advantages, including its model-free nature, applicability to diverse data types, and multivariate approach. For instance, Herzog et al. (2022) demonstrated its clinical potential by using an information-based technique to identify biologically plausible markers for Alzheimer's disease and frontotemporal dementia. Despite its success in such applications, the framework's key limitations lie not in the analytical methods themselves, but in the researcher's ability to obtain the right experimental data to address specific research questions

(Timme & Lapish, 2018). The limitation rooted in appropriate data, rather than information theory itself, highlights the adaptability of the framework rather than reflecting a weakness, underscoring its versatility across diverse applications. By circumventing the constraints of model-based methods and offering clinically relevant insights, information theory provides a transformative framework for advancing neuroscience beyond pairwise models.

## Conclusion

This review highlights the transformative potential of high-order frameworks in advancing our understanding of brain dynamics, overcoming the limitations of traditional pairwise approaches. Frameworks such as hypergraphs, simplicial complexes, and information theory enable the analysis of multivariate interactions and emergent brain dynamics, offering powerful tools to unravel the brain's complexity.

Model-based approaches, such as hypergraphs and simplicial complexes, provide structured frameworks to explore neural network topology. However, their reliance on predefined assumptions and parameters can limit flexibility. In contrast, model-free approaches like information theory offer an unbiased perspective, quantifying multivariate interactions through measures like entropy, redundancy, and synergy. Despite these strengths, they cannot generate descriptive models of system functionality, underscoring the complementary nature of both approaches.

By embracing high-order methods, neuroscience has the opportunity to move beyond traditional pairwise models, capturing the dynamics of the brain more realistically. The integration of topological and statistical frameworks offers significant potential for groundbreaking discoveries in brain function, such as the mapping of physical environments and subjects positions derived from firing of neurons, representing a critical transition point in our understanding and analysis of the human brain.

## Future Research Perspectives

The integration of information theory with simplicial topology represents a promising direction

for the future of computational neuroscience. By combining their respective strengths — information theory's capacity to characterize multivariate dependencies and algebraic topology's ability to model higher-order connectivity — these frameworks could open new avenues to investigate the relationship between structural and functional connectivity in the brain.

Notably, algebraic topology introduces the concept of holes — topological features that prevent a structure from being reduced to a single point. This idea suggests that a system like the brain, which contains many such features when analyzed through simplicial homology, may be inherently irreducible to a low-dimensional model. Rather than being a limitation, however, these holes could offer a unique window into the study of emergent mental properties.

This shift in perspective could represent a conceptual turning point: the very features that resist simplification may hold the key to understanding phenomena like consciousness. Future research could explore whether these topological features correspond to functionally relevant cognitive processes, or whether they can be used to delineate the boundary between physical brain activity and the subjective experience of the mind.

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## Social Sciences

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# Ecocide in Gaza? A Comparative Analysis of Three Legal Frameworks in International Humanitarian Law for the Prosecution of Environmental Destruction by Israel in the Gaza Strip

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Ryan Kruijt



*An aerial view taken on Jan. 19, 2025, of destruction in Jabalia in the Gaza Strip captured from a drone by journalist Mahmoud Isleem al-Basos. Al-Basos was killed by Israel on March 15, 2025. Mahmoud Isleem al-Basos/Anadolu via Getty Images (2025).*

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**Author Note:**

This paper was written in March 2024 and edited between March and May 2025. While the content of the paper does not reflect changes since March 2024, all statistics are updated in their respective footnotes to outline the situation as of early 2025.

**Introduction**

Since the events of October 7, 2023, many legal accusations have been made concerning genocide or genocidal intent by Israel in the Gaza Strip<sup>1</sup>. One aspect that remains underexamined, however, is the environmental destruction caused by the conflict both in terms of current quality of life and future habitability in the region. Specifically, little attention has been paid to the legal mechanisms available for addressing this environmental harm or for holding Israel accountable under international law.

Some media outlets and scholars have referred to these harmful acts as “ecocide” (Ahmed et al., 2024; Kawash, 2023; Milieudefensie, 2023). Coined by biologist Arthur W. Galston at the Conference on War and National Responsibility in 1970 in Washington, D.C., ecocide was defined as “the willful and permanent destruction of environment in which people can live in a manner of their own choosing” (Zierler, 2011, p. 19). Indeed, Galston found this act to be so severe that he likened it to genocide, arguing that it should be considered a crime against humanity — a claim which has been echoed by scholars ever since (Mehta & Merz, 2015). In this context, the University of London, Goldsmiths’ research group, Forensic Architecture, has stated that “the destruction of agricultural land and infrastructure in Gaza is a deliberate act of ecocide” (Weizman, 2024). Similarly, Abeer Al-Butmeh, coordinator for the Palestinian Environmental NGOs Network, asserts that “what is happening is, for sure, ecocide” (Ahmed et al., 2024).

However, both claims, as well as the definition provided by Galston, have no legal basis, given that no provision currently exists under international humanitarian law criminalizing ecocide as a distinct offense. Accordingly, this paper asks: To what extent can Israeli-caused environmental degradation in the Gaza Strip be viewed as a vio-

lation of international humanitarian law, and what does this reveal about the limitations of current legal frameworks for prosecuting environmental destruction? To answer this, a comparative analysis of three legal definitions of environmental destruction, including one specifically for ecocide, will be conducted. Following an illustration of the political landscape between Israel and Palestine and the environmental destruction caused by Israel in Gaza, the paper introduces and analyses each legal definition and the facts within these frameworks to evaluate the potential for legal accountability of Israel.

Two of these legal definitions are embedded in international law — one in the Rome Statute and another in Additional Protocol I to the Geneva Conventions — while the third, developed specifically for the prosecution of ecocide by an Independent Expert Panel set up by the Stop Ecocide group, has not been adopted. The analysis will examine each definition in terms of its jurisdiction, subject of jurisdiction, intent and causality, and (conjunctive) formulation, in order to assess the stringency of each article’s threshold.

In analyzing these definitions, two observations will be made. Firstly, by evaluating the potential for legal accountability of Israel, it is noted that all current statutes in international law have a high legal threshold for prosecution. Taking this into consideration, the paper furthermore notes the inadequacy of international law in addressing widespread environmental harm. To address this gap in accountability, it proposes considering a legal definition of ecocide to facilitate the prosecution of environmental destruction.

**Background**

In 1948, the Jewish Agency of the Zionist World Organisation proclaimed the establishment of the State of Israel in what was then British Mandate Palestine. This immediately led to conflict, with the surrounding Arab states and Palestinian forces declaring war on the newly established state. As a result, at least 750,000 Palestinians were dis-

<sup>1</sup>Following March 2024, a consensus has been achieved among experts that the acts of war committed by Israel against the Palestinian people amount to genocide (Amnesty International, 2024b; OHCHR, 2024).

placed, often through violent means, and many were expropriated of their land, belongings, and property (Almagor et al., 2024; United Nations, 2023). Additionally, the war contributed to the expulsion of many Jewish communities in majority-Arab countries, often fleeing to Israel. In the aftermath of the war, Israel expanded its territory beyond the borders outlined in the 1947 United Nations Partition Plan, which proposed to divide British Mandate Palestine into two states, forcing Palestinians who had not yet fled to neighboring countries into Gaza and the West Bank, together referred to as the Occupied Palestinian Territories (OPT).

Since then, there has been continuous animosity between Israel and the OPT. In March 2024, Amnesty stated that since its inception Israel has created and maintained a “system of oppression and domination against Palestinians” which amounts to apartheid (Amnesty International, 2024a). The UN Special Rapporteur for the situation of human rights in the Palestinian territory occupied since 1967 has concluded the same, citing the torture and extrajudicial killings of Palestinians, along with the demolitions of their homes by the Israel Defense Forces. Moreover, due to the dire living conditions in Gaza and the travel restrictions imposed on its inhabitants by Israel, the Gaza Strip is often referred to as an “open-air prison” (United Nations, 2022). The rapporteur furthermore considers the “deeply discriminatory” legal and political system which privileges the 700,000 Jewish settlers, living in 300 settlements spread across the West Bank and East Jerusalem, over Palestinians. These settlements are a violation of international law (United Nations, 2022).

Against this backdrop of restricted space, limited resources, and the illegal settlements, there has been an ongoing dispute about environmental resources between Israel and the OPT, which are largely under Israeli control (Schlütter, 2005). Continued political and military antagonism has exacerbated this conflict, particularly following Hamas’ attack on Israel on October 7, 2023, during which approximately 1,200 Israelis were killed (Mackenzie, 2024) and another 251 were taken hostage (Ryan & Pengelly, 2023). Israel’s subsequent retaliation is estimated to have led to the deaths of circa 35,000 Palestinians and the detention of at least 9,000 Palestinians in Israeli pris-

ons, often without charges and under inhumane circumstances<sup>2</sup> (Boxerman, 2024; Reuters, 2024).

In this context, the paper has carefully considered the terminology it adopts. Language concerning the Israel-Palestine conflict has long been a contentious issue, with differing narratives being reflected in the terminology adopted by different parties. Consequently, the paper predominantly follows the vocabulary employed by the United Nations and Amnesty International. Nevertheless, the paper does not adopt this language uncritically. Take for example the violent events of 2008, a three-week conflict beginning on 27 December 2008 after several hundred rockets were launched from Palestine into Israel, killing nine people. In response, Israel launched operation “Cast Lead,” during which approximately 1,400 Palestinians were killed and more than 3,400 Palestinian families lost their homes (Almagor et al., 2024; Amnesty International, 2009a; OHCHR & PCHR, 2017). In referring to these events, many authoritative bodies adopt the terms “war” or “conflict.” The paper instead uses the term “Gaza Massacre,” based on the significant asymmetry in casualties between Palestinians and Israelis. Here, referring to the events as a “war” may suggest an equal power distribution where there is none.

Similarly, in referring to the 2021 two-week outburst of violence in East Jerusalem, the terms “crisis” or “escalation” are frequently used (OCHA, 2021). In light of the significant number of casualties — with 282 Palestinians and 13 Israelis killed, and nearly 9,000 Palestinians injured — these terms are considered insufficient to capture the gravity of the events. Instead, this paper adopts the frequently used name “2021 Unity Intifada.” The word “Intifada” is used in Arabic to refer to an uprising, in this case against Israel. This terminology is deemed more fitting because, contrary to the word “crisis,” it does not situate the event in a political vacuum but instead accounts for the context in which it originated: an uprising is always against something. In the case of the 2021 Unity Intifada, the events unfolded while anticipating the Israeli eviction of six Palestinian

<sup>2</sup>As of April 2025, more than 50,000 Palestinians have been killed by Israel’s military actions, although this is likely a low estimate (Khatib et al., 2024; PCBS, 2025). A further 18,700 Palestinians have been detained and 123,000 have been wounded, according to the Gaza Ministry of Health.

families in East Jerusalem.

Having considered the terminology, the paper returns to its main focus, namely the environmental destruction resulting from the conflict. Taking place almost exclusively within the OPT and predominantly in Gaza, one of the main subjects of contention is agriculture. Land in the region has always been relatively arable, with farms and orchards covering about “47% of Gaza’s total land area” (Weizman, 2024). However, constant exposure to battle has significantly decreased the amount of arable land. According to estimations by the United Nations Satellite Center (UNOSAT, 2024), circa 34% of arable land and crop fields in Gaza exhibited a “significant decline in health and density in January 2024” and analysis shows that “21% of the arable land has been damaged.” By February 2024, Forensic Architecture stated that “Israeli military activity had destroyed more than 38% of [the arable land]” (Weizman, 2024). The Guardian combines the figures of farmland with those of tree cover and states that anywhere between 38 to 48% thereof has been destroyed (Ahmed et al., 2024). The Guardian further notes that, in response to this, the Israeli Defense Forces (IDF) stated that it “does not intentionally harm agricultural land and seeks to prevent environmental impact absent operational necessity.”

Indeed, in almost every instance where the IDF causes environmental destruction, it is allegedly out of operational necessity. In one case along the border of Gaza, the Israeli government seeks to ensure that farmland destroyed there by the IDF remains permanently uninhabited, with some officials suggesting “the creation of a buffer zone” (Nakhoul et al., 2023). In another situation, Bellingcat, an open-source investigative journalist collective, states that Israel has cleared approximately 1,740 hectares of land by destroying farms, crops and vegetation, in the same area where they have constructed a new road (Chaudhuri & Godin, 2024). The IDF has said this is out of “military necessity” (Ahmed et al., 2024).

Another crucial aspect of the current conflict is the weaponization of water by Israel. According to Hamas, some Israeli hostages are being held captive in an intricate tunnel network that runs under most of Gaza (Arranz et al., 2023). To force Hamas and the hostages out of this network, Israel has considered flooding the tunnels with seawater (International Court of Justice, 2023, p. 106). The

International Court of Justice states that, according to environmental experts, this tactic would risk “causing an ecological catastrophe,” leaving Gaza without drinking water and devastating the already crippled agricultural sector. It would also jeopardize the region’s entire water and sewage systems, causing long-term “long-lasting contamination of Gaza’s aquifer and soil.”

The aquifer referred to here is the Coastal Aquifer Basin, which runs along the Mediterranean coast from Egypt’s Sinai region, through Gaza, and into Israel (Schlütter, 2005). It delivers the majority of Gaza’s water supply, sometimes as much as 80% (Gayle, 2023). While this basin is also used to supply water to Israeli settlements, both these and the state of Israel itself have sufficient water because of their advanced desalination networks, allowing them to rely on seawater as a source of clean water (Debre, 2023). Additionally, this means that any degradation or salination of the aquifer will not affect water access in Israel (or Israeli settlements) as severely as in the Gaza Strip. This was evidenced by the shutdown of wells and desalination facilities, as a result of both deliberate destruction by the IDF and the siege Israel is imposing on Gaza, which blocks the necessary fuel to run the facilities (Devlin et al., 2024; OCHA, 2023). As a result, Gazans live off an average of three litres of water daily, far below the minimum UN emergency standard of 15 litres a day, with as many as 70 percent of people having to drink brackish, contaminated water from wells (Hall et al., 2024).

Aside from attacks on water treatment plants, wastewater facilities have also been destroyed in the history of Israel’s occupation of Palestine. Following the 2008 Gaza Massacre (sometimes also referred to as the First Gaza War), the damage to some facilities in North and Central Gaza caused wastewater to flood more than one square kilometer of farmland and residential areas, resulting in destroyed crops and posing significant health hazards (Amnesty International, 2009b). Similarly, the 2021 Unity Intifada, a two-week outbreak of violence caused by the anticipated Israeli eviction of six Palestinian families in East Jerusalem, saw untreated wastewater flowing into streets, lakes and the sea as a result of the damaged infrastructure (Hall et al., 2024). In the current war, the threat of raw sewage polluting the aquifer and the sea is even greater. According to Shaddad At-

tili, former head of the Palestinian Water Authority, all sewage treatment plants are defunct due to the lack of available fuel since Israel's siege of the region (Gayle, 2023). As a result, the United Nations Environment Program (UNEP) estimated that 100,000 cubic metres of wastewater are siphoned into the Mediterranean daily (Ahmed et al., 2024). This has had drastic effects on the fishing industry in Gaza, which was already significantly diminished due to Israel's imposed fishing border just nine kilometres off Gaza's coast. Anyone who crosses this border is at risk of being injured or killed by the Israeli navy (Wadi, 2023). As a result of wastewater leaking into the Mediterranean, United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA, 2013) writes that "Gaza's fishermen are forced to fish in mostly polluted water."

Any impact on the Gazan fishing industry will inevitably significantly impact its population. According to an assessment by the Palestinian Union of Agricultural Work Committees, the sector employed over 4,000 people in 2022, with hundreds of others working associated jobs (UAWC, 2023). Before the current war, it is estimated that the sector provided necessary food for circa 110,000 people in Gaza.

Apart from in the sea, however, the violence has also unfolded in the air. Since at least 2014, Israel has been spraying herbicides along the border with Gaza, causing them to drift into the territory and destroy farmlands and vegetation (Weizman, 2019). Furthermore, the Guardian writes, "people have become overwhelmed by pollution in the air," in part due to the fumes emitted through bombing, and in part due to the lack of fuel, forcing Palestinians to resort to scraps of wood and plastic to build fires (Ahmed et al., 2024).

Still, the majority of environmental destruction takes place on land, with UNEP estimating that Israeli bombing resulted in almost 23 million tonnes of debris and dangerous material containing asbestos, heavy metals, unexploded weapons and harmful chemicals (Ahmed et al., 2024). Indeed, some of the bombs dropped on Gaza have been proven to contain white phosphorus (Arms & Ristic, 2023; Human Rights Watch, 2023), a substance that ignites upon contact with oxygen and is extremely difficult to extinguish. The chemical is harmful to humans as it sticks to clothing and

skin and causes deep burns that can penetrate bone (WHO, 2023). Exposure to white phosphorus can lead to respiratory damage, organ failure and eye injuries. The substance can persist in soil and water for up to several years before it degrades, and fish inhabiting contaminated lakes or rivers can accumulate white phosphorus in their bodies (ATSDR, 2014).

Given the extensiveness of Gaza's environmental devastation resulting from Israeli military operation, the necessity of a critical examination of Israel's military acts under international law is once more underlined. From the contamination of vital water sources to the erasure of agricultural land, the profound environmental destruction could have lasting ecological consequences, in addition to endangering the lives of more than two million Palestinians.

## Rome Statute

The first definition under which members of the Israeli military or government could be prosecuted for environmental destruction is Article 8(2)(b)(iv) of the Rome Statute of the International Criminal Court (1998), described thusly,

Intentionally launching an attack in the knowledge that such attack will cause incidental loss of life or injury to civilians or damage to civilian objects or widespread, long-term and severe damage to the natural environment which would be clearly excessive in relation to the concrete and direct overall military advantage anticipated.

Firstly, considering its position in the Rome Statute, the legal framework for the International Criminal Court, this Article can solely be applied to the prosecution of individual perpetrators, either those actively partaking in the alleged crimes or those ordering others to carry them out, as per the doctrine of command responsibility (Mettraux, 2009). As such, the definition does not account for the ambiguities concerning which individual persons, through their actions, caused severe environmental damage. Furthermore, indictments made to those in superior positions are unlikely, since there needs to be proof of 1) a superior-subordinate relationship existing at the time of

committing the crimes and 2) the superior having knowledge of the actions of his subordinates, or their intention to do so. As of yet, concrete proof for both of these requirements is lacking regarding any superior figures.

Moreover, the phrasing of the Article effectuates a high threshold for any prosecution to take place (Freeland, 2015). Attesting to this is the fact that it has never been applied in the history of the ICC (Younes, 2024). Firstly, the *mens rea*<sup>3</sup> of the Article requires proof that the perpetrator had “knowledge” of the negative consequences of their actions (entailing “incidental loss of life or injury to civilians or damage to civilian objects or widespread, long-term and severe damage to the natural environment”) and still launched their attack “intentionally.” Proving intentionality is notoriously complex, even more so when considering the case of Israel’s herbicide drifting into Gazan agricultural land, where the IDF could easily argue that this is merely an unintended side-effect of their use of herbicides over their own land. Even if intentionality could be proven, for example on the basis that the IDF burns tires prior to its use of herbicides to determine whether the wind is moving westward into Gaza, it would still be questionable whether this constitutes an act of “widespread” and “severe” damage.

In addition, it must be proven that any attacks by the perpetrator are “clearly excessive” considering the “concrete and direct overall military advantage anticipated.” This clause is specifically problematic in our case because Israel regularly adopts this rhetoric, which is difficult to verify since the information is often classified, to justify its attacks. This was also applied, for example, when the IDF destroyed Gazan agricultural land with the use of white phosphorus (Arms & Ristic, 2023; Human Rights Watch, 2023). In this case, it stated that “ Hamas often operates from within orchards, fields, and agricultural land,” thus turning it into a viable military target (B’Tselem, 2002, p. 3). It remains to be seen whether the usage of white phosphorus here is “clearly excessive,” considering the dire environmental implications (Mojabi et al., 2010).

In any case, the damage must not only be clearly excessive – it must also be “widespread,

<sup>3</sup>“Mens rea” refers to the intent behind a criminal act, indicating whether there was knowledge of wrongdoing when committing an offense.

long-term and severe.” The conjunctive nature of this clause requires that all three of these criteria be met, adding to the high threshold. While most cases of environmental destruction in Gaza meet at least one of these, satisfying all three criteria will prove difficult. Consider firstly the notion of “long-term”; as Article 8(2)(b)(iv) has never been applied in a case before, it is unclear what constitutes long-term, whether this would be months, years or even generations (Bagheri, 2024, p. 2).

Consider the Israeli military’s usage of white phosphorus. According to Mojabi et al. (2010), this substance may persist in the soil for years without degrading. Furthermore, in the border area between Gaza and Israel, where most of the white phosphorus has been used and where farms have been repeatedly under Israeli attack through shelling and bulldozing, some Israeli officials have proposed the creation of a “buffer zone,” i.e. the eradication of all farmland in this vicinity for the foreseeable future (Nakhoul et al., 2023). Lastly, according to Bellingcat, circa 1,740 hectares of land seem to have been cleared south of Gaza City for the creation of a new road (Chaudhuri & Godin, 2024). Though these acts all seem to attest to the longevity of the situation, it remains uncertain whether this would be considered sufficient in the eyes of the ICC.

Indeed, even if one could additionally prove the damage to be “widespread”, considering that the afflicted area seems to constitute at least 1,740 hectares, and “severe”, given that white phosphorus has destructive effects on humans and the environment, the issue of responsibility remains. The IDF has repeatedly stated that these attacks are a “military necessity,” an assertion which is difficult to assess due to the restricted access to military intelligence, likely nullifying any legal accountability through the aforementioned clause on military advantage (Ahmed et al., 2024).

Finally, regarding jurisdiction, while Israel is not a signatory of the Rome Statute, Palestine is (International Criminal Court, 2024). As a result, the International Criminal Court can exercise jurisdiction over the case of environmental destruction by Israeli forces in Gaza, should they be presented with it, on the basis of the principle of territoriality. This doctrine dictates that the Court has jurisdiction in situations where a crime was committed in the territory of a State Party, regardless of

whether the perpetrator is a signatory of the Rome Statute (International Criminal Court, 2020).

## Protocol I

The second definition of ecocide under which the Israeli military or government could be held accountable is Article 55 (1) of Protocol I<sup>4</sup>, a 1977 amendment protocol supplementing the 1949 Geneva conventions with the purpose of protecting war victims internationally (United Nations, 1977). The Article describes ecocide as follows,

Care shall be taken in warfare to protect the natural environment against widespread, long-term and severe damage. This protection includes a prohibition of the use of methods or means of warfare which are intended or may be expected to cause such damage to the natural environment and thereby to prejudice the health or survival of the population.

Concerning the possible accused under this article, while Palestine has signed and ratified Protocol I, Israel has not (ICRC, 2024). Nevertheless, being the first additional protocol to the Geneva conventions, the definition here is generally perceived to have “gained the status of Customary International Law” and is consequently applicable in the International Court of Justice, regardless of its signatories (Doctors Without Borders, n.d.). Thus, while no individuals can be held accountable under this Article, the State of Israel itself can be held liable for violations thereof.

Regarding the formulation of the Article, the first aspect that is vastly different from Article 8(2)(b)(iv) of the Rome Statute (1998) is the usage of “care” in the first sentence. It implies an obligation of conduct: the expected behavior of states, to which they shall adhere, has been outlined. This is contrary to the Rome Statute Article, which establishes a standard based on the outcome or result of the attack, emphasizing what “such attack will cause.” Furthermore, the notion of intentionality, which underpins the previous Article, is not integrated into the current one. In practice,

<sup>4</sup>Officially, the *Protocol Additional to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts*

these differences could mean that the (accidental) attacks on sewage plants, which result in the leaking of sewage into the Mediterranean, are better suited for prosecution. This is because Article 55 (1) of Protocol I pends on proving the lack of taking “care” rather than on intentionality and the “knowledge” of the bombing’s aftereffects.

In the second sentence, the Article prohibits the use of weapons or warfare which, through damage to the environment, may “prejudice the health or survival of the population.” This is an important clause in the example of Gazan fishermen, since their health and survival are particularly threatened by the environmental damage caused by Israel leaking sewage into the Mediterranean Sea.

Still, Article 55 (1) has a high threshold of establishing harm (Hulme, 2010), akin to the Rome Statute Article, evidenced by the conjunction in the clause “widespread, long-term and severe damage.” In this sense, prosecution under this definition encounters some of the same obstacles as the Rome Statute Article, requiring the simultaneous demonstration of multiple incriminating elements.

Lastly, in light of the Article’s position in Part IV, Section I, Chapter III of the Protocol, titled “Civilian objects,” the environment is *prima facie*<sup>5</sup> a civilian and therefore gains certain accompanying protections, according to Karen Hulme (2010). Notably, it gains protection through the principle of proportionality, outlined in Article 55(4), which prohibits indiscriminate attacks. Specifically, Article 55(5)(b) defines an indiscriminate attack as “an attack which may be expected to cause incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof, which would be excessive in relation to the concrete and direct military advantage anticipated.” In the case of the usage of herbicides by Israel along the border of Gaza, Forensic Architecture states that it “causes indiscriminate damage” and would thus constitute a violation under the Protocol (Weizman, 2019). This is provided that this operation is considered an attack and not an unfortunate incident. Again, since the provision of excessiveness is mentioned, the usage of herbicides should also not effectuate (significant) military advantage.

<sup>5</sup>At first sight; in this context used to denote first and foremost in the eyes of the law.

## Independent Expert Panel

The final definition under which the Israeli military or government could be held accountable is that of the Independent Expert Panel (IEP) for the Legal Definition of Ecocide, convened by the Stop Ecocide advocacy group (Stop Ecocide International, 2021). The formulation of the Article, which I will examine below, has rendered it one of the most comprehensive and expansive legal definitions of ecocide to date, with an actual possibility of prosecution, which is said to be unlikely in the other definitions. Though the Article itself is not in force anywhere in the world, an altered version has been adopted by the European Parliament as a directive at the end of 2023 (European Parliament, 2023). The main body of the original Article defines ecocide thusly: “For the purpose of this Statute, “ecocide” means unlawful or wanton acts committed with knowledge that there is a substantial likelihood of severe and either widespread or long-term damage to the environment being caused by those acts.”

Since the IEP Article is not enacted into law anywhere, the following analysis will be hypothetical, serving as a means to understand the implications of the Article should it be enacted <sup>6</sup>. Notwithstanding, this particular definition of environmental destruction, or ecocide, is unlike the others considered previously because it criminalizes intent. Kate Mackintosh, Executive Director of the UCLA Law Promise Institute Europe and Deputy Chair of the Independent Expert Panel, says of this: “The crime is not making the damage happen. (...) It’s creating substantial risk of that damage” (Younes, 2024). Already, this offers a legal basis for the prosecution of Israel’s plan to pump seawater into Gaza’s tunnels. While pumping efforts had begun on a small scale in December 2023, they seem to have halted since (Youssef et al., 2023). Under the other two Articles this act would not be punishable, since it has not caused any “widespread, long-term and severe damage.” However, considering the damage that would have occurred if Israel continued

<sup>6</sup>In no way am I proposing that the acts of Israel can be deemed illegal retroactively, in accordance with the principle of *nullum crimen sine lege* — literally, “no crime without law” — which states that no punishment can be imposed except for an act that was already criminalized at the time it was committed (Rome Statute of the International Criminal Court, 1998, art. 23).

with the plan, along with the fact that Israel clearly intended to do so by beginning their operations, prosecution under the current Article would likely be possible.

Indeed, not only does the IEP Article focus on intent, but it also lowers the threshold of harm by writing “severe and either widespread or long-term damage,” thus making the two latter criteria disjunctive. Now, damage has to be proven to be either severe and widespread or severe and long-term, allowing for a broader scope of acts to be prosecuted. In the case we are considering, this could entail prosecution of the usage of white phosphorus, since it was applied solely in specific regions in Gaza and consequently might not be considered widespread. Moreover, it could mean that Israel’s bombing, specifically its creation of debris and hazardous waste in Gaza, could be prosecuted for being “severe” and “widespread” damage, but not long-term per se. This is important since in this article, too, what constitutes “long-term” remains ambiguous, with the term being defined as “damage which is irreversible or which cannot be redressed through natural recovery within a reasonable period of time” (Stop Ecocide International, 2021). While the notion of irreversibility is quite clear, the time frame considered “reasonable” lacks a precise definition. As a result, it is uncertain whether the lasting effects of some of Israel’s acts, such as the herbicide spraying on Palestinian farmland, will fall within this “reasonable” period. To clearly define this reasonability would require more case studies, which is beyond the scope of this paper.

Lastly, the Article not only concerns “unlawful” acts but also “wanton” ones, which the Independent Expert Panel describes as “reckless disregard for damage which would be clearly excessive in relation to the social and economic benefits anticipated” (Stop Ecocide International, 2021). Utter recklessness, thus, is explicitly mentioned in the Article – a notion absent from the Rome Statute Article and merely implied in the Protocol I Article.

## Conclusion

This paper has highlighted the profound scale of the ongoing devastation in Gaza, as caused by the Israel Defense Forces. Considering the influence of these acts on the people in Gaza

and the environmental toll, it is critical to understand both the applicability and limitations of international law in addressing and prosecuting such harm. Through the comparative analysis of three legal definitions on environmental damage – the Rome Statute, Protocol I and the Independent Expert Panel convened by the Stop Ecocide group – it is shown that existing international frameworks have exceedingly high thresholds regarding accountability. The definition outlined in the Rome Statute as well as in Protocol I requires proof of “widespread, long-term and severe damage,” terms that have not been properly defined in international law. Furthermore, accounting for the complex and equally undefined standards of intent and proportionality in these articles – evidenced by the phrases “care shall be taken” in Protocol I and “clearly excessive” in the Rome Statute – efforts to hold Israel (or Israeli actors) accountable will prove difficult.

By contrast, the definition of ecocide offered by the Independent Expert Panel lays out a more accessible legal pathway for the prosecution of environmental harm. It does this foremost by criminalizing intent, considering the mens rea of certain acts. Along with this, the threshold for prosecution is lower than in the Rome Statute and Protocol I, since the definition provided by the IEP does not necessitate proof of irreversible damage. Furthermore, its disjunctive formulation and explicit acknowledgement of wantonness provide a more flexible framework as opposed to the conjunctive nature of both other articles.

In considering the legal definitions of environmental harm under international law, this paper underscores the importance of working towards a more encompassing legal framework, facilitating more effective prosecution not only in the context of Gaza today but in future cases worldwide. Although further research is needed to evaluate the practical implementation of such frameworks, their development remains essential for both environmental protection and the safeguarding of human life internationally.

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## Social Sciences

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# The Little Brother's Revolt: The Role of National Identity in Slovakia's Autocratic Turn

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*Slovak PM Robert Fico is welcomed by Vladimir Putin in Moscow. Alexander Zemlianichenko (2025).*

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**Introduction**

“There are no two nations in the world closer to one another than Czechs and Slovaks,” proclaimed former Slovak president Zuzana Čaputová during her final official visit to Prague — a day which signalled a historic transition. In many ways, she was correct. The two share over 70 years of modern history, including that of Soviet totality, a linguistic closeness, and a legacy of a peaceful coexistence as well as peaceful separation in what has come to be known as the Velvet Divorce. In the words of political scientist Petr Pithart (2024): “After all, where in Europe are there two nations next to each other that understand each other’s language and have never done anything wrong to each other?”

And yet, a major divide between the sister nations has emerged, symbolically embodied within the 2024 Visegrad Four meeting, as the leaders of the Czech Republic, Hungary, Poland, and Slovakia split along ideological lines during their meeting in Prague. As the Czech Prime Minister Petr Fiala and President Petr Pavel discussed amping up support for Ukraine with the Polish PM Donald Tusk in the Prague Castle, Slovakia’s newly elected PM Robert Fico, the leader of Smer (eng. Direction), joined the Hungarian Prime Minister Viktor Orbán in meeting the pro-Russian former Czech president Miloš Zeman (iDNES.cz & ČTK, 2024). Since then, Slovakia has replaced Poland as Hungary’s closest ally and co-troublemaker within the European Union (EU), in what Ivan Kalmar (2022) calls “Central Europe’s illiberal revolt” — a response to the perceived denial of equal treatment following the EU’s Eastern enlargement. In Slovakia, this anti-progressive attitude has expanded beyond discrimination against minorities to include attacks on democratic institutions and the rule of law. Fico’s policy agenda arguably aligns with Scheppele’s (2018) concept of autocratic legalism, where electoral mandates are used to legitimize constitutional and legal changes advancing an illiberal agenda, and to erode systems of checks and balances, democratic safeguards which prevent one individual,

group, or institution to exercise absolute control and escape accountability. This political divergence between Slovakia and the Czech Republic illustrates the need for a comparative examination of their evolving national identities. In particular, the current context of the war in Ukraine and the rise of the far-right in Europe calls for a deeper understanding of individual Eastern and Central European countries like Slovakia and of their own distinctive relationships with Russia, nationalism and democracy.

As such, this essay will explore the history of the Czech and Slovak nations, with particular focus on how the key moments of divergence — the formation of Czechoslovakia, the Second World War, the Velvet Revolution and the Velvet Divorce — have shaped their distinct political orientations. Ultimately it will answer the question: what historical, sociopolitical, and cultural factors have driven Slovakia at once toward authoritarianism, and politically away from the Czech Republic, despite their shared history and intertwined identities?

**Recent Trends: Democratic Erosion in Slovakia**

While the Czech Republic matches Slovakia in anti-Islamic and anti-immigrant sentiment (Kalmar, 2022, p. 171) as well as in systemic discrimination against the Roma people (Musil & Podlešák, 2023), its politicians have so far refrained from attacking democratic constitutionalism. Conversely, since taking office, Robert Fico’s government has made strides in a number of illiberal reforms which serve to undermine accountability structures and loosen restraints on executive power. Robert Fico’s criticism of public broadcasters first surged during a political crisis sparked by the 2018 murder of investigative journalist Ján Kuciak, who had been investigating high-level corruption involving government officials (Guardian staff reporter, 2018). The subsequent investigation was widely perceived as compromised, leading to mass protests, which ulti-

mately compelled Fico and his entire cabinet to resign (Walker, 2019). Now back in power, Fico has moved to replace the public broadcaster RTVS with the state-run STVR, granting his ruling coalition control over appointments to its directorial board (Jochecová & Nicholson, 2024). Furthermore, Fico's government took steps to disband the police agency responsible for investigating ties between ruling party politicians and organized crime, including those implicated in the murder of Kuciak (Madleňák, 2024). Additionally, his administration passed penal reforms that reduced sentences and tightened statutes of limitations for corruption, enabling many Smer politicians to evade justice, and abolished the office of the special prosecutor, thus undermining the rule of law (Braxatorová, 2024).

Robert Fico's populism is undisputed, but unlike Czech populism, it carries a deliberate rejection of post-communist country's democratic signifiers, such as independent media and pro-Western foreign policy orientation. The performativity of Fico's alleged social democratic allegiance is evidenced by the fact that Smer has been suspended from the Party of European Socialists on account of violations of social democratic principles (EuroNews, 2023). Rhetorically, Fico is known to borrow from both the left and the right (Bayer & Burke, 2024), promising greater social security in alignment with the former, while casting minorities and political opponents as threats to the nation in line with the latter (Čevelová, 2022). Leaning particularly conservative on social issues, Smer targets Slovakia's LGBTQ+ community in order to consolidate their coalition's power by fueling the tensions between Bratislava's wealthier progressive population and conservative rural voters. In striking similarity with Orbán's tactics, Fico is also targeting his opponents and various NGOs under the justification that they follow the orders of George Soros (Bayer & Burke, 2024), the billionaire philanthropist who Orbán claims to be plotting the destruction of Hungary. Finally, Fico's government promptly halted all military support to Ukraine (Camut, 2023) and began to diplomatically ally itself with Moscow (Jochecová, 2024a), vetoing EU sanctions against Georgian officials responsible for the crackdown on protesters opposing Russian influence in December 2024 (Liborero, 2024), and even appearing on a Russian TV propaganda channel to criticize the EU's support

of Ukraine (Kačmár, 2024). This could not be in sharper contrast to the consistent financial aid and diplomatic backing provided to Ukraine by the Czech Republic (Reuters Staff, 2024), and the prevailing anti-Russian sentiment rooted in the lived national experience of Soviet imperialism (Government of the Czech Republic, 2024), a memory that appears conspicuously suppressed in the current Slovak national consciousness (Pešeková, 2022).

The recent parliamentary and presidential elections in Slovakia — where the presidential race saw the victory of Peter Pellegrini widely considered a proxy of Fico who defeated Ivan Kořčok, a pro-Western former diplomat (Stoklasa & Lopatka, 2024). These results reveal a stark chasm between Czech and Slovak attitudes toward democracy, governance, and crucially, their relationship with Russia. The relative novelty of this development has resulted in a limited body of explanatory literature. Additionally, Western commentators have a tendency to under-analyze Slovakia in their reporting, reducing it to just another illiberal nation in Central Europe and likening it to Hungary (for example, as discussed in (Bayer, 2023; Cameron, 2023; Minder, 2024)) rather than examining it in a more meaningful context — specifically through a contrast with its historically, linguistically, and culturally close neighbor, the Czech Republic. Understanding the reasons behind Slovakia's authoritarian shift requires a comparative analysis of each country's national identity as charted throughout their intertwined, yet at crucial points diverging histories.

## Historical Roots of Czech-Slovak Differences

### The First Republic

The establishment of Czechoslovakia in 1918 following the collapse of European empires at the end of the First World War already contained seeds of discord. The nation emerged from the collapse of Austria-Hungary, legitimized by US President Woodrow Wilson's "14 Points" proposal, which called for "the freest opportunity of autonomous development" for its peoples and their protection among nations (Severa, 2019). In building their sovereign state amidst the ruins and

chaos of post-WWI Europe, the architects of the new Czechoslovakia, thus, had motivations beyond mere linguistic similarity in the union. Notably, these nations came from distinct parts of the Austro-Hungarian Empire — the Czechs under Austrian administration and the Slovaks under Hungarian administration. Politically, the addition of Slovakia to the Czech lands was seen as a way of securing agency for the new democracy, by creating a Slavic electoral majority capable of overruling the German-speaking population inhabiting the Czech border territories (Kosatík, 2018). In spite of the varying levels of cultural stifling under Austrian dominance, by WWI the Czechs had gone through a national revival, and carved out for themselves a degree of cultural power and political influence in the Empire as inhabitants of the subordinate, yet relevant, Lands of the Bohemian Crown (Wiskemann et al., 2025). Contrastingly, prior to the First Republic, Slovaks in what was known as Upper Hungary lacked the same level of autonomy or a sense of nationhood (iDNES.cz & ČTK, 2018). In the newly born Czechoslovakia, with Czechs as the dominant ethnicity occupying the richer, more industrial territory, Prague as the capital, and the Czech political fight against the Germans at the forefront, Slovak nationals could already then feel themselves “playing second fiddle”.

## World War II

The foundations of Slovak illiberalism can be traced all the way back to World War II in the first iteration of Slovak national independence in the Nazi-allied Slovak State. After the Munich Agreement of September 1938, Czechia’s border lands were annexed by Germany, only for the whole territory to be eventually seized and forced into the status of a Third Reich protectorate. In 1939, Jozef Tiso, a Catholic priest, declared Slovakia’s independence and became the president of the first Slovak Republic (Zeman, 2020). However, the newly independent Slovakia became a German satellite state, where the control of key industries was seized by Berlin, and its domestic and foreign policy were completely subordinated to Nazi interests (Hosenseidlová, 2019; Zeman, 2020). Slovak soldiers fought alongside Germans on the Eastern Front, while 70,000 Slovaks were simultaneously being deported to Nazi internment camps

(Zeman, 2020). Although a valiant partisan resistance emerged, and eventually brought about the Slovak National Uprising in 1944 — which took place in opposition to Tiso and with the expressed wish to reinstate Czechoslovakia (Posh, 2024) — it is forever part of Slovak history that their first experience of nationhood was co-signed by Adolf Hitler.

Even though Czechoslovakia reunited eventually in April 1945, their two distinct wartime experiences inevitably became ingrained in the states’ respective national consciousnesses. The martyrdom of the protectorate gave origin to the Czech self-perception as the peaceful bastion of democracy, abandoned by its allies and threatened on all of its borders by violent neighbors. After the war, this exaggerated narrative of martyrdom legitimized the brutal ethnic cleansing of the German civilian population from the Czech borderlands (Preiss, 2024). To this day, this flawed national mythos of democratic exceptionalism — the ideological belief that a nation’s identity is inherently tied to democracy, and thus inherently moral — prevents the reflection on the morality of the post-war treatment of the Czech-German population, and perpetuates the logic which later gave origin to the Czech national identification with Israel, as one such other supposed “bastion of civilisation and democracy in an aggressive region” (Čejka, 2020; Záhora, 2017). However strong this democratic identification and democratic reverence — a strong ideological commitment to the principle of democracy, characterized by a tendency to venerate democratic ideals as intrinsically good — is in Czech self-perception, the lack of constructive discourse about democratic ideas and legacy gives way to the straw-manning and distorting of democratic principles to a point where they risk becoming void. The universal, undiscerning support Czech governments have historically given to any and all Israeli action (Preiss, 2024; Šlechta, 2012) is only one such example of the risk of democratic perversion.

Contrastingly, however, where Czechs saw the German occupation as the end of their statehood, for Slovaks it was its creation. In the words of the Slovak historian Ivan Kamenec, “If someone in the Czech Republic tried to celebrate the protectorate and claim that it was the brightest period in Czech history, they would probably be locked up in a madhouse” (Hosenseidlová, 2019). In Slo-

vakia, the legend of statehood as the highest peak in the development of the nation persists among a part of the population to this day.” Parts of Slovakia still consider the wartime president Tiso a hero, and the far-right party *L’udová strana Naše Slovensko* (eng. People’s Party Our Slovakia) is explicitly founded on the same national, social, and Christian tenets as the Slovak fascist party that allied itself with Hitler, *Hlinkova slovenská l’udová strana* (eng. Slovak People’s Party).

### **Socialist Czechoslovakia and the Velvet Revolution**

Though the two nations grew closer once more during the time of actually existing socialism, the cultural and political dominance of the so-called “Prague café” (a pejorative frequently used by populists to describe intellectual urban elites) prevailed. Many Czechs viewed Slovakia as the less developed, more religious, folkloric part of the nation, admired more so for its natural beauty than its cultural fabric, which remained headed by Prague in a self-reinforcing cycle of prejudice (Rychlík, 2023). Correspondingly, a Czech sense of superiority solidified, exemplified in the patronizing nickname for Slovakia — “the little brother”. Notably, the influence disparity manifested even during the pivotal moment of the anti-communist Velvet Revolution of 1989. In Prague, on November 17<sup>th</sup>, 1989 a student-led march, initially organized to commemorate the 50<sup>th</sup> anniversary of the Nazi suppression of student protests, evolved into a demonstration against the government. Thousands of students, intellectuals, and opposition groups took to the streets, calling for democratic reforms and in the face of overwhelming public pressure, the Communist Party peacefully stepped down, paving the way for the democratic transition that followed. Although Slovak civil society, namely “Verejnost’ proti násiliu” (eng. The Public Against Violence), led a valiant struggle parallel to the “Czech Občanské Forum” (eng. Civic Forum) (RTVS & TASR, 2022), the Prague epicentre and its leading figurehead, Václav Havel — Czech writer, dissident, organizer, and the first president of the new democratic republic — render the Czech identification with November 17<sup>th</sup>, if nothing else, symbolically easier.

Czech politicians continue to celebrate the November 17<sup>th</sup> anniversary of the Velvet Revolu-

tion as the ultimate ritual of democratic redemption — a faith-sustaining practice whereby democracy is revered as an intrinsically valuable process rather than merely a set of bureaucratic procedures (Canovan, 1999). This guards a government against populism, which emerges as a response to a perceived lack of democratic redemption but itself offers no pragmatism, which in turn makes a system vulnerable to corruption. During the 2024 Czech commemoration of November 17<sup>th</sup>, both the government and the opposition sought to portray themselves as heirs to this freedom-fighting legacy. The current ruling coalition used the anniversary to legitimize their pragmatic slogan, “TOGETHER we do, what must be done” (SPOLU, 2024) through partaking in the iconography of democratic redemption. Meanwhile, right-wing populists strategically redirected their rhetoric to the WWII origins of the 1989 student protests, in order to equate Nazism with Germany and draw parallels to the EU while conveniently avoiding discussions of Soviet imperialism (Okamura, 2024) — an omission aligned with their pro-Moscow rhetoric. Nevertheless, even these attempts at its co-option are testaments to the significance of the democratic legacy of 1989 in the Czech Republic, and its centrality in Czech national identification across the political spectrum. As such, understanding the Velvet Revolution celebrations as an indicator of democratic reverence, it should be more than telling that Robert Fico failed to organize any celebrations at all (Jochecová, 2024b).

### **The Velvet Divorce (1993)**

In 1993, Czechoslovakia split into two independent states, the Czech Republic and Slovakia, in a remarkably peaceful separation. The partition, which came to be known as the Velvet Divorce, was driven by divisions regarding, among other factors, contrasting conceptualizations of shared statehood. Where the Slovak population fought for the Federation to be viewed as a union between two different nations, the demographically and culturally dominant Czechs perceived Czechoslovakia as their own country, merely expanded eastward (Rychlík, 2023). To this day, the Czech Republic’s citizens see their country as a continuation of Czechoslovakia. A testament to this is that Czechs celebrate the 1918 anniver-

sary of the founding of the first Czechoslovak Republic as the birth of their statehood, as opposed to the 1<sup>st</sup> of January 1993 when the Republic in which they now live was created (Rychlík, 2023). Thus, after the separation, the Czechs were naturally poised to embrace the democratic legacy of Czechoslovakia: its proud democratic origins, its wartime martyrdom, and its eventual triumph over totalitarianism. In contrast, the Slovaks could not share in this national narrative to the same extent, partly due to the political divergence during World War II and partly because of their limited identification with the ever so dominant Czech culture — one of the primary reasons why they sought to establish independence in the first place. Henceforth, as the Czech national identity firmly rooted itself in the nearly century-old Czechoslovak narrative of democratic struggle, Slovak national identity had lacked clear definition since the Austria-Hungary period and remained malleable.

As Slovakia began to chart a new path of independence for itself, its ambiguous self-image made it more susceptible to coaptation by populist narratives. In fact, Fico's rise to power is not the first instance of a dark period of fascist statehood coming to haunt Slovakia. The authoritarian Mečiar government (1994-1998) saw extensive democratic backsliding, numerous attacks against journalists, as well as the intimidation of independent media and attempts to subjugate them to the state (Jochecová & Nicholson, 2024). Robert Fico's Smer can thus be argued to have emerged as an echo of Mečiarism.

## Irreconcilable Differences

Though populism is believed to arise at times of poor economic performance, Veronesi & Pastor (2019) argue that it often emerges in prosperous times as a response to income inequality. In the case of the Czech Republic and Slovakia, the sharpness of austerity reforms after the revolution certainly had an effect on public dissatisfaction with the new democracy, particularly in Czechia, which was heavily influenced by British Thatcherism (Kalmar, 2022, p. 203). However, as Kalmar (2022) argues, the galvanizing factor for populism in Central European countries was not merely their national condition, but

the disappointing treatment they received from the West following the post-communist transition. Having finally returned to what they perceived as their rightful home in the West, the Visegrád Four soon became resentful of Western nations, who were seemingly unwilling to grant them admission to the club of democratic equals. By 2005, some observers began critiquing the EU's treatment of Central Europe as a form of postcolonial control, marked by unequal exchange, stereotyping, and the export of governmental practices through EU requirements (Kalmar 2022, pp. 200–202). The so-called illiberal revolution was thus a result of pent-up frustrations with the West, and manifested itself in an unwillingness to extend solidarity to migrants and minorities. After all, Poland, Hungary, and Czechoslovakia never had any colonies, and instead were themselves exploited by empires (Kalmar 2022, pp. 216–218). While this sentiment is prevalent across the Visegrád Four, it is unsurprising that Slovakia, being diplomatically and economically weaker as well as in the market for a new national identity, has internalized it to the extent of rejecting liberal democracy outright.

Slovakia, unlike its sister-nation, slipped through populism into the territory of autocracy not just because of its greater political vulnerability within the new global order, but also owing to its national identity's weaker identification with it. As explored above, Czechs have a significantly stronger attachment to the legacy of Czechoslovakia and its mythology of democratic exceptionalism. As Brubaker (2017, pp. 279–280) writes, "populism grows out of the lack of affective enchantment with democracy." The success of either is therefore contingent on affective nationalism, which manifests as the banal affirmation of the national emerging in moments of emotional encounter between bodies and objects (Militz & Schurr, 2016). Hence, an emotive interactionist celebration of the 1989 Velvet Revolution anniversary creates a symbiosis between Czech national and democratic allegiance. Coming back to Margaret Canovan's *Two Faces of Democracy* (1999), the historic national identification with democratic values thus enhances Czech democracy's redemptive capacity. In contrast, Slovakia, glaringly lacking an independent national narrative, became much more vulnerable to not just populist tactics, but to attacks on the rules of the

game themselves — liberal constitutionalism and democratic institutions. Furthermore, it is essential to recognize that in the context of Czechoslovakia, the marginalization of democratic struggles often entails an omission of reasons as for why these battles were necessary — namely to combat Russian imperialism. This illuminates, in part at least, the ease with which Robert Fico has been able to cultivate ties with Moscow.

## Conclusion

The rise of Robert Fico and Slovakia's turn toward autocratic legalism can be understood through an analysis of the divergences in Czech and Slovak history, which reveal themselves as promising explanatory variables of their respective national identities. Slovakia's pivot to autocratic legalism under Fico is partially a result of a lesser national democratic reverence.

Historically, Slovakia's experience of independent statehood was defined through its role as a Nazi satellite state, and its post-communist identity has thus been less tied to a narrative of democratic struggle. In contrast, the Czech Republic's identification with democracy, which it has been able to maintain due to Czech cultural and political dominance in the Czechoslovak Federation, strengthens the national faith in democratic redemption, making it less susceptible to the kind of antidemocratic populism. That said, the Czech Republic is far from being immune to populism. Rather than coming from a lack of reverence for democracy itself, Czech populism is kept alive through the persistent synonymizing of freedom with neoliberal capitalism, and the popular grievances which arise from austerity. And yet, owing to the deep national identification with democratic legacy, unlike Robert Fico, Czech populists have so far refrained from attacks on liberal constitutionalism itself.

However, Czech democratic identity has a troubling undercurrent of unsceptical credulity which stifles critical reflection on its history, its relationship with Israel, and the very meaning of democracy itself. As such, it remains uncertain how long this democratic mythos will stand to support genuine democratic values, or how long before Czech voters can be persuaded that democracy entails dismantling anti-corruption in-

stitutions and silencing the voice of independent media. In the same vein, Fico's election is by no means indicative of an inherent anti-democratic disposition within the Slovak national soul, but rather a consequence of centuries of national suppression, including Czech paternalism. Slovakia, still a young democracy, holds the potential to carve out its own future firmly within the hands of its people. In fact, modern Slovakia has witnessed profound moments of democratic fervor — be that during the public outcry following the murder of journalist Ján Kuciak, the election of the progressive human rights lawyer Zuzana Čaputová as president, or the outpouring of defiant citizens who flooded public squares to force Robert Fico out of power back in 2018. Those same passionate crowds could rise again<sup>1</sup>.

It may well be that despite their apparent estrangement, the two sibling countries are themselves on the same boat, in much closer quarters — balancing together on the tightrope between democracy and autocracy.

<sup>1</sup>Beginning December 23<sup>rd</sup> 2024, mass demonstrations against the government have indeed once again erupted all over Slovakia (Prok & redakcia/PEN, 2024), catalyzed by Fico's plan for a diplomatic visit to Moscow amidst the ongoing Russian invasion of Ukraine. The protesters demand his resignation as well as a shift in foreign policy towards a pro-Ukrainian, pro-NATO, and pro-EU direction (Vilček, 2024). As of May 2025, these protests have incessantly continued (iDNES.cz, 2025).

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# Humanities

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## Layers of Resistance: Protest Stickers and the Participatory (Counter-)Memory of Urban Space

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*Spotting stickers in their urban habitat. Designed by the author (2021).*

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## Introduction

Protest stickers are ephemeral yet powerful agents of cultural memory, transforming urban landscapes into contested spaces of resistance, memory, and identity. In contrast to traditional monuments, which impose singular, static narratives, stickers operate as counter-memorials, subverting dominant commemorative practices through their impermanence, accessibility, and creative materiality. These small-scale, low-cost artefacts mediate public memory and assert a “right to the city” by turning walls, lampposts, and benches into living, participatory archives. Practices of sticking, layering, peeling, and covering public surfaces allow for the continual negotiation of meaning and the formation of counter-hegemonic geographies of resistance.

Grounded in theoretical frameworks such as Aleida Assmann’s notion of archives and Carl Fox’s and James E. Young’s work on counter-monumentality, this study argues that protest stickers create fluid, non-linear spaces of remembrance that respond to ongoing social and political struggles. Supported by auto-ethnographic accounts of sticker-related practices in Amsterdam, London, Wrocław, and Katowice, this research explores how stickers function as both a grassroots form of civic engagement and an ephemeral yet persistent mode of resistance. Ultimately, this paper contends that protest stickers politicise everyday spaces, enabling individuals and communities to reclaim urban environments as evolving, participatory arenas of cultural memory and activism.

Since the 1960s, stickers have been a popular means of communication, both commercially and politically (Reershemius 623). With unique and distinctive graphics, typography and symbols, stickers have become a staple of many protest movements, making it easy to ‘tag’ spaces with meanings, political demands or calls to action. Made from cheap and accessible materials such as paper or vinyl, accommodating both hand and digital designs, and easily reproducible in large quantities but small in size, stickers are “portable, concealable and shareable” (Bodden and Awcock 134). These affordances of stickers enabled by their materiality, according to Awcock, affect “how their message is communicate[d]” and how it is interacted with (524). Not only are they used to promote and spread certain meanings, but their

geographies, socio-political contexts and proximity to other objects create one-of-a-kind instances of creative expression. Due to the size constraints of stickers, their messages are imbued with references to historical symbols and phrases, situating them within larger historical contexts of resistance (Reershemius 633), thus making them transcend their ephemeral temporality (Assmann 97). In turn, this use of visual resources “can make new protests legible to outside audiences” (Ross 1224).

Reershemius, Bodden and Awcock write that although pedestrians pass by stickers daily, they are not acutely aware of them (626, 131). Stickers require a certain level of visual literacy, which makes them appear as “more subtle and ignorable political claims than protests,” yet, “they are a pervasive method of resistance employed by activists from across the political spectrum” (Bodden and Awcock 131). From my experience, being attentive to street stickers allows one to read the stories, struggles, and tensions imbued in the urban surfaces. Their presence and familiar symbols remind me of the vastness and complexity of human experiences, and evoke a sense of belonging, participation and solidarity. Although I cannot access the particular intentions or even imagine the face of the person who placed them there, I feel a sense of community — our paths crossing and interacting, speaking to each other despite the displaced timing. Moreover, my demands, opinions, voice and obligation to justice are shared and amplified. In many ways, stickers bridge individual expressions and collective actions. As Visgo notes, stickers “appear in public space as a sign of activism, but the activist remains faceless, a collective rather than a number of individuals” (qtd. in Awcock 525). In this sense, my perception of certain stickers, related to climate, Pro-Palestinian, Antifascist, Pro-Abortion, Queer and more, trigger memories and sensibilities tied to resistance, affirming my right to the city and my participation in a struggle much bigger than myself.

When large and performative events such as demonstrations disperse, they often leave ‘adhesive’ traces behind that remain on public surfaces long after these physical gatherings end (Ross 1225). They keep the protest demands, chants, and symbols present in otherwise ‘neutral’ public sites, highlighting the political nature

of urban landscapes (Awcock 528). For example, when I was organising climate protests in 2019, my movement would give out stickers designed by talented and local artists, such as Noriaki Kasai, a famous creator of the *Watcher* (Pan Peryskop) from Poznań (Figure 1), to the participants to flood the city with climate messages and recognisable to the citizens symbols. Although the use of stickers is treated as a form of vandalism and is, strictly speaking, illegal, stickers “can be classified as part of a transgressive discourse in the widest sense” (Reershemius 640). The accessibility and discretion of the act of placing the sticker make it a fun and participative practice, which democratises the space in ways exceeding conventional forms of protest. Moreover, their low risk and anonymity emancipate “vulnerable and marginalised communities” to participate in political discourse and express values in public (Bodden and Awcock 131).



Figure 1: *The Watcher* sticker for Młodzieżowy Strajk Klimatyczny (Fridays For Future Poland) by Noriaki Kasai (from personal collection).

In London in April 2022, during a prolonged climate mobilisation that included, among other things, marches, bridge blockades and artistic interventions throughout the city, my activist friends and I were given large rolls of Extinction Rebellion stickers (Figure 2). With some practice, we were able to stick hundreds of climate symbols within hours by simply going on a walk around the

city, without the need to plan our route or slow down. This experience demonstrates how ordinary sticking can be. A brief touch of the urban surface leaves a visual mark behind. This effect is particularly striking when stickers are distributed through the simultaneous movement of many dispersed individuals and groups — large urban areas can be covered with new symbols and urgent messages within hours. Consequently, this visual abundance of protest symbols may draw the attention of passers-by and embed its design in their memory, creating a sense of familiarity and recognition. This increases the chances that one stops, takes a closer look and enters the urban dialogue.



Figure 2: *Extinction Rebellion UK* sticker (from personal collection).

In this sense, stickers become a form of commemoration of events, whether related to a protest, collective effort or individual initiative, which simultaneously can vandalise and reject other institutionalised forms of commemoration (Fox 12). They directly express dissent and create a grassroots dialogue with public infrastructure, subverting public statues or spaces’ original meanings and aesthetics. One of the most prominent and recent examples would be placing stickers with text along the lines of “This Company’s Funds Support the Palestinian Genocide” next to the entrances of McDonald’s, Starbucks and many other commercial spaces with known ties to Israel (Figure 3). Part of the Boycott, Divestment

and Sanctions (BDS) movement, this physical intervention connects the sites of consumption with annihilation of Palestine, simultaneously educating citizens, calling for action, and making a company's political complicity evident (Reershemius 640). Here, stickers transform remembrance in public spaces as responsive to ongoing issues and expressive of the needs of local and global communities, without posing significant risks or consequences to the activists.



Figure 3: *Buying From This Company Supports Genocide* sticker (from personal collection).

Practices around stickers can also manifest as conversations between subcultures and counter-cultures. Often, when I pass through the street and see racist, xenophobic, misleading or harmful stickers, I intervene by peeling, covering up or scraping them with keys. This practice is quite common, and the traces of these transformations often remain to remind us of the extremist, violent and harmful stances. Bodden and Awcock write that through such acts, “racism can be, and is being, countered and condemned” (142). Although the viewers might not necessarily agree with such transformations, they would nonetheless recognise them as a conflict, “and therefore understand racism as something that should be, and is being, challenged” (Bodden and Awcock 142). Those interventions, however, are at times difficult or dangerous due to the deliberate efforts to protect stickers from removal. Often, they may be placed

in spots difficult to reach. But it is more alarming in the case of particularly extremist groups, which place razor blades under stickers to physically injure anyone who might condemn their beliefs. This only reveals how significant stickers and their legibility are for some, and to what extent they are willing to go to keep their messages on the surface of the urban spaces.

The layering of stickers, either intentionally to comment on or cover something up, or accidentally, reveals their palimpsestic potential, which reduces the deeper layers into unreadable noise, while maintaining the memories of their existence (Reershemius 634). These communicative encounters are “situated in and conducted through environments, rather than suspended abstractly between individuals” (Bodden and Awcock 134), which potentially can foster engagement within and between communities in a “constructive political dialogue on a more regular basis” (Fox 9). In turn, these exchanges and interactions between stickers, agents and environments dissolve the “sense of a single authority: ... [revealing] that the work was never really self-possessing and autonomous [and] is now made palpable to viewers” (Young 279).

Practices revolving around activist stickers, such as designing, printing, distributing, sticking, removing, covering, sharing and altering, blur the distinctions between the actor and an audience, as “stickers are more than vehicles for information because those who encounter stickers can — and frequently do — respond to political stickers in ways that exceed ‘passive’ reading. They act on stickers in various ways to formulate an equally public reply” (Bodden and Awcock 134). Then, according to Bodden and Awcock, their sense of meaningfulness is shaped by people’s actions and reactions, as well as by the visible remnants of past activities that stickers reveal to the public (132). Further, similarly to other forms of counter-cultural urban means of communication such as graffiti and street art, stickers repurpose and challenge the intended functions of objects in public spaces, uncovering the creative and radical possibilities of urban environments beyond their current state (Bodden and Awcock 132).

Stickers, when left behind or ‘abandoned’ in public sites, are exposed not only to local communities and their responses but also to weather conditions, which exacerbate their processes of

washing out and fading away, and thus forgetting. In Assmann's terms, stickers undergo both passive and active forgetting through the different ways they encounter local communities and conditions. Active forgetting can be understood as "intentional acts such as trashing and destroying," which, in this case, are used as communicative and meaning-making affordances (Assmann 97–8). On the other hand, the abundance, cluttering and neglect of stickers in urban spaces form "no longer needed or immediately understood" archives (Assmann 106). Reershemius points out that stickers in clusters often become unreadable or invisible, blurring their distinctive messages (627). They simply blend into an aesthetic and a "civic wallpaper" (Fox 2), but once someone takes a closer look, the stickers can be rediscovered and can inform new meanings inferred from the clusters and collages they form. Even if their original meaning is indecipherable, stickers leave traces of (inter)actions, visualising temporal processes. Through such an urban archive, we can position ourselves in time; "it affords us the possibility of comparison and reflection for a retrospective historical consciousness" (Assmann 106). These similarities to Assmann's notion of archive are striking, however, sticker archives which exist outside of institutions reveal that democratic, ever-present and accessible archives are possible, thus contesting her institution-centred definition. Moreover, as stickers fade away into eternal forgetting, they create space for new images. The old can be replaced, and the space can be finally re-used, moving on from old meanings. Perhaps this seemingly contradictory 'impermanent archive' is at once a counter-memorial, which allows, through forgetting, to "make place for new information, new challenges, and new ideas to face the present and future" (Assmann 97).

This closely resonates with Young's and Fox's arguments for impermanent statues/monuments. As Young puts it: "the actual consequence of a memorial's unyielding fixedness in space is also its death over time: a fixed image created in one time and carried over into a new time suddenly appears archaic, strange, or irrelevant altogether" (294). But also the meaning and memories carried by objects diminish over time, and "as people become accustomed to it and memories of salient background details begin to fade away"

(Fox 5). Here, stickers as living, changing, participatory and reactive medium of public memory and communication may realise the hope "that the counter-monument will incite viewers, move them beyond vicarious response to the actual, beyond symbolic gesture to action" (Young 281).

The impermanent and palimpsestic characteristics of stickers reveal how their form and related practices allow for "fresh act[s] of communication with the public," as they are continuously made, re-made, and transformed according to the unfolding events and community needs (Fox 7). This way, stickers can remain relevant as they refer to (symbolically) and remind (physically) about past events while expressing present stances and values of freedom projected into more just futures. This reveals an entanglement of temporalities which complicates how memory construction is understood. Young problematises the linear approach to studying memory: "the very notion of linear time assumes memory of a past moment ... In this sense, the counter-monument asks us to recognize that time and memory are interdependent, in dialectical flux" (Young 294). In other words, the linear perception of the processes of memory and remembrance oversimplifies the multitude of ways in which memory is recalled, instead treating it as complete and fixed. Memory undergoes transformations and reconfigurations depending on the context and the challenges of the unfolding 'now'. As such, stickers and their relations with environments mirror the complexities of remembering and forgetting. In this sense, stickers create ephemeral, living and evolving forms of counter-remembrance.

This paper underscores that the medium of stickers is inseparable from their message, yet their transient nature necessitates evolution. As stickers fade or become cluttered, their messages risk blending into the urban backdrop unless revitalised or reimagined in new forms. This observation invites further exploration into other ways stickers are used, such as in alternative archives and personal collections, displays on private items and their role in identity formation. Through that, the analysis of protest stickers and related practices may gain new dimensions of (im)permanence and accessibility, along with their role in counter-memory making. The use of stickers as an activist tool warrants deeper investigation, particularly how they are distributed

among collectives, how they reveal civic entanglements beyond local contexts and interact with non-urban spaces.

Ultimately, protest stickers, through their materiality, the practices surrounding them, and layered meanings, contribute to struggles for justice by politicising everyday spaces and empowering individuals to participate in the ongoing construction of public memory. They reveal the creative and radical potential of urban environments to transcend their intended functions, inviting communities to reimagine and reclaim the spaces they inhabit. These living, participatory archives affirm that resistance and solidarity are not confined to monumental actions but thrive in the palimpsestic, the ephemeral, and the ordinary.

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## Humanities

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### “I’m in a grave situation”: Stone and Deathscapes

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*Bochkarova Galina Alexandrovna and Smirnov Yuriy Nikolaevich.* Photograph from the author’s personal collection (1995).

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“There is an impulse to lay stones upon graves, to blur the line between human and stone, to say *You were here* and *I was here* and *We were here*. As if we might forget. We hold fast to stones at times, as if they might connect the living and the dead. Lithic lines start to blur, animating what seems inert.”  
— Gretchen E. Henderson, “A Philosophy of Stones” 54

Death and corpses stalk and suffuse human life. Evidence of intentional burials — indicated by, for example, the positioning of skeletons in graves and the presence of grave goods<sup>1</sup> — goes back as far as 120,000 years ago (Wightman 188-191). Alongside those ancient graves, at times, came grave markers, like flat stone slabs and piles of rocks or earth (Wightman 190). They “[gave] a sense of permanency to burials,” expressed “historical claim over land and individuals,” and “might have been revisited and attended by rituals of remembering” (Wightman 190). The purpose of contemporary grave markers — regardless of form, shape, appearance, and material — often remains the same. In this paper, I want to specifically focus on the materiality of the grave marker, the stone in *gravestone*, so to speak, and I will do so through a discussion around my grandparents’ headstone. I will explore the following question: *How do dynamics of distinction, exclusion, and care play out through stone as a grave marker material?* I will begin by examining the relation between wood and stone within my grandparents’ grave, then analyse the history of grave marker materiality that shapes this contemporary relationship, and then briefly focus on the dynamics of care wrapped up in attending to a deceased loved one’s grave marker.

After my grandmother passed away in early February of 2022, she was buried at an old cemetery in a Russian village, where she’d lived for the past few decades. Her first grave marker was a simple and cheap wooden cross made of light-coloured wood.<sup>2</sup> When my grandfather died in early March of 2023, he

<sup>1</sup>Items buried alongside a deceased individual.

<sup>2</sup>To clarify, temporary crosses placed on a grave the day of a burial are not necessarily always wooden. For example, they can also be made of lightweight metals but I will only discuss wood in this paper, as that is the material that was used for my grandparents’ temporary grave markers.

was buried next to my grandmother and received a similar cross. In the summer of 2024, my family completed the process of commissioning and putting in place a granite gravestone. In the case of my grandparents’ gravestone, the materials of wood and stone exist in a relation where one “succeeds” the other; the former is “temporary,” and the latter “permanent.” I want to linger on this for a bit.

To some degree, the distinction (the temporariness of wood, and the longevity of stone) and the direction of relation (the eventual “succession” of stone over wood) between the two materials can appear almost natural, “rational.” Trees grow and are harvested within a human lifespan. The degradation of wood often adheres to a similar timeline — it can quickly grow mould, splinter, burn, or become a home to insects. Stone, however, depending on the type, is a hard material formed in locations beyond our reach like deep underground, during a span of time far exceeding a human life. Further, wood and trees are organic, while stone is not. A tree may grow sick, or die — it fails as reliably as the human body, while stone does not. Therefore, from an anthropocentric perspective, stone presents permanency and stability of being, while wood instead shows fragility, temporariness, and ephemerality (which we may also see within ourselves). This tendency towards decay and vulnerability to the environment is why so few ancient wooden grave markers survive into the modern day, whereas many stone markers remain intact (Snell 113).

Once they died, my grandparents’ bodies began to slowly degrade and distort beyond anything recognisable to my family and me. Their eventual decomposition uprooted their “being,” and thus my family’s grief ceased to have a stable and persisting object to anchor upon. When the physical bodies decay to nothing, how do I find my grandparents in the cemetery? Where would I go to grieve them,

and where would my family gather on the anniversaries of their deaths? If a wooden grave marker were to take the place of that anchor, be a substitute for flesh and blood, it would degrade as surely and visibly as their bodies. A granite headstone, however, is seemingly protected from uncontrollable deterioration. Thus, it presents a “permanent” material to anchor the being of the deceased, and an individual’s or a collective’s grief. It carries the identity of my grandparents, even “[reviving them] into the consciousness of the living who never knew them” (Stott 50). The granite headstone “does some of the work of holding a person in the world after the living body has ceased to do that work” (Stott 50) — the choice of material ensures that when I leave Russia and return months later, the gravestone of my grandparents will remain as it was upon my departure.

However, the permanency of stone and the temporariness of wood are not a given. With proper maintenance and planning, wooden grave markers can survive for decades. For example, some wooden materials like teak are more resistant to weathering and damage from insects and thus can be extremely durable (Arunkumar et al. 174). The wooden marker can also be treated with oils or chemicals to ensure protection against, for example, rain (Striegel et al. 17). Stone is not truly infallible either — it can crack, be weathered down by wind and damaged by cleaning agents (Striegel et al. 8). Earlier in this article I felt comfortable making the generalisation that “stone is hard,” but this is also not always the case as some types of rock like chalk are notoriously brittle. Additionally, organic matter like moss and lichens can grow over grave markers. Therefore, the strict dichotomy of “temporary” and fragile wood versus “permanent” and stable stone is not so clear-cut or rational. Furthermore, the very importance placed on the permanency of a grave marker (and by extension, of the deceased) is not universal either. For example, Māori funerary traditions necessitate letting “the flesh to rot away” to facilitate the rest of the burial process which deals directly with the deceased’s bones (Rangiwai 229, 236). Stott similarly notes that the “desire to maintain a person’s presence in the world eternally through a physical monument to the

individual . . . runs counter to many indigenous worldviews,” like those of various Native American groups (77).

As I have demonstrated, while it may feel natural for a “permanent” granite headstone to replace the “temporary” wooden cross to ensure the longevity of my grandparents’ memory, that feeling of “naturalness” is artificial. Wood and stone can fluctuate between states of stability and decay — they may be equally long-lasting or short-lived and similarly be protected from nature or susceptible to her whims. The desire for an individual’s permanency through specifically stone is not a natural or rational desire present in all humans and all cultures, it is contextually informed. In other words, the materials of wood and stone are “mediated for us humans by the institutions and environments in which [they are] situated” (Zylinska 55). The two materials come into being as discrete objects (“temporary” and “permanent,” one “better” than the other) precisely because of the relations contained within the gravestone (Zylinska 45). Therefore, a brief (considering the scope of this article) examination of some of the historical practices that shape contemporary encounters with the materiality of grave markers is prudent.

Though there are regional differences, the histories of grave marker materials across Western countries share some similarities. The scholars I cite in this paragraph analyse specific cemeteries and grave markers in countries like England, the United States, and the Netherlands, though I use their insights to make general observations. Broadly speaking, in the lead-up to the 18<sup>th</sup> century, grave markers increased in popularity as a whole, and wood, due to its availability and malleability, was often the most common material. For example, in New England, during the 16<sup>th</sup> century, graves were often left unmarked, and it was only in the 17<sup>th</sup> century that grave markers gradually became more common (Riordan 35). According to Hijiya, many mid-17<sup>th</sup> century colonist graves in America were “marked only by a wooden sign, an uncut rock, or nothing at all” (343). It was largely towards the 18<sup>th</sup> century that headstones became more popular in colonial America (Hijiya 341). Meanwhile, in cemeteries situated between Luxembourg and

Germany, “since the 10<sup>th</sup> century, stone material for grave marking was mainly used by the elite of the society,” and up until the 18<sup>th</sup> century the wooden cross was generally the most common (Streb 58). Further, Richards observes that in the Netherlands, “as stone was scarce and expensive,” wood was the preferred material for grave markers “well into the 20<sup>th</sup> century” (8).

In short, during the 18<sup>th</sup> and 19<sup>th</sup> centuries due to the Industrial Revolution, the increased availability of desirable materials (e.g. blue-stone), and improved methods for working with them (Streb 40) stone markers gained popularity. When discussing a Swedish cemetery, Tagesson remarks that in the late 18<sup>th</sup> century an egalitarian burial system was adopted in the graveyard, and graves were oriented “one after the other without consideration of parish, social status or age” (Hassler qtd. in Tagesson 24). Despite that, grave markers still acted as a site for expressing social status (Tagesson 24). This expression occurred in various ways, such as the style of the headstone, inscriptions on it, and specific graveyards used for burial. However, my focus remains on the materiality of the grave marker, and how it contributed to the formation of the wood/stone dichotomy described above and class-based dynamics of exclusion.

To illustrate how this wood/stone distinction and class relationships intersect, I will focus on the example of England. Around the middle of the 19<sup>th</sup> century, English cemeteries had become locations where class relations played out particularly visibly. Burial in “garden cemeteries” was fashionable at the time, and many elaborate memorials, grave markers, and monuments lined the most visible areas of these graveyards in displays of wealth (Tarlow 229). During this time, the English middle class amassed significant purchasing power, and became interested in acquiring the “enclosing and individualizing space” of privately owned cemetery plots (Tarlow 230). Such private ownership is a pathway for a “materialistic expression of success,” that entails not just land ownership, but the ability to erect a durable and permanent stone grave marker (Mytum qtd. in Tarlow 231). A headstone, thus, becomes a symbol that “[proclaims] own-

ership of the place, not only at the moment of burial but also projected into the future.” (Tarlow 230-231). Therefore, the middle and upper classes had access to “the future security of the burial place” afforded by a private plot and the durable headstone contained therein (Tarlow 232).

In contrast, however, the working class “could not afford a proper burial, let alone a headstone” and were often buried in the more affordable “common graves” (Evans 125). These were deep graves without a headstone shared by multiple unrelated individuals. According to Evans, some of them are “even said to be twelve metres deep in places, housing up to thirty bodies at a time” (125). Further, the lower class would be buried in “pauper’s graves.” These were reserved for those who lived and worked in a workhouse, could not afford a funeral, and had no family or friends to bury them (Strange, “Only a Pauper Whom Nobody Owns” 148-149). They would be cheaply buried by municipal authorities in unmarked graves.

In ancient Greece and Rome, everything, from the mundane to the official, from jokes to laws, was all “inscribed onto and into” the walls of public buildings, making them “definite and ascertainable,” inseparable from the city itself (Mattern, “Of Mud, Media” 314-315). In a similar fashion, the carving of a curated self (encompassed in the elaborate designs, the personal details, and any quotes or lettering) into a granite headstone and projecting this self onto all who walk past it, granted those who could afford it “permanent” visibility. Their being was inseparable from the public space of the cemetery, like a scar on the body of the city making them mournable, extant as individuals beyond death. The working and lower classes existed (and in many contexts still exist) in an antithetical position where “the pauper corpse rotted in anonymity” (Strange, “Only a Pauper Whom Nobody Owns” 148-149). Within this opposition, the circumstance of temporariness — the fast decay of the wooden cross and the immediate disappearance of the unmarked person — collects the labels of poverty, failure, and shame (Strange, “Tho’ Lost to Sight, to Memory Dear” 145), while the longevity of the stone acquires a position of perceived superi-

ority, informing the earlier discussed “succession” of stone over wood.

Thus, through this examination of the histories of gravestone materiality, we can see the unravelling of the seemingly rational and natural dichotomy of wood versus stone and superiority of permanence over transience. The value of longevity is partially constructed by its proximity to wealth. I want to stress that I am not saying that the concept of “permanence” is not real; it is very “real” in that it affects the material conditions of various individuals. For example, Halberstam discusses Weston’s work on the “[privileging of] longevity over temporariness and permanence over contingency” in interpersonal relationships (72). When permanence is uncritically used as a universal measure of worth for relationships, short-term, new, non-familiar, and non-marital forms of kinship are “rendered meaningless and superficial” (Halberstam 72). It is precisely for this reason that I explore the histories of grave marker materiality: to begin destabilising taken-for-granted notions of superiority and value.

On my grandparents’ headstone are their names, their dates of birth and death, and a three-bar orthodox cross in the corner — it shows their tumultuous but shared life (one headstone but different last names), their faith (the cross and the implication of icons decorating their home and of my grandmother’s whispered prayers), and how long they spent apart. When my family visits, we uproot the weeds, wipe down the stone, light a candle, and leave some candy or flowers for them. We take care of my grandparents *through* the granite. A blurring of boundaries occurs — my grandmother, my grandfather, and their gravestone exist together in unity. Though often in literature stone is conceptualised as cold and unfeeling (e.g. “stone-hearted,” “a stony expression,” “cold as stone”), within the context of the grave marker, the granite becomes a locus for intimacy and familial care. The feeling is so palatable, that after some consideration, I decided not to include a photo of the headstone in this paper, as it feels personal, private. Though the cemetery is public, I feel distinctly uncomfortable with the headstone being on display in this paper, which will indefinitely be available

for download by whoever, whenever.

Before exploring the implications of this affective attachment to the grave marker through the deceased it represents, I want to critically approach the idea of *care*. In her article “Maintenance and Care,” Mattern discusses the “everyday work of maintenance, caretaking, and repair.” Most of all, she emphasises the relevance of not romanticising practices of care — it is important “to reckon with its troubling histories and administrative structures,” and to ensure that the “privileged position of the caring subject” is acknowledged (Martin et al. qtd. in Mattern, “Maintenance and Care”). “Care” can be and has been mobilised in service to colonialist projects with paternalistic overtones (Mattern, “Maintenance and Care”), wherein the sovereignty, personhood, and autonomy of others is undermined. Therefore, as Mattern points out, it is important to supplement an understanding of “care” with decolonial theory, as scholars like Prattes and Nayak do extensively, to critically examine the positionality of those who enact the said care. In the context of the gravestone, the reality is that many are systematically denied the chance and space to enact care over their deceased loved ones. A distinct aspect of the pain involved in the aftermath of a pauper burial was “the denial of mourning customs,” of a procession, a eulogy, a location for mourning and coming together in collective grief (Strange, “Only a Pauper Whom Nobody Owns” 150). This denial, in different form and measure, has been imposed on Indigenous groups whose burial grounds have been historically desecrated by white settlers, and now on Palestinians whose cemeteries run out of space and whose graveyards are purposefully destroyed under Israel’s continuous onslaught (“No Rest for Gaza’s Dead”; Slow), and many others. Thus, I feel it necessary to acknowledge the space of privilege I hold, of the ability and space to continually grieve, repair, and experience catharsis, while many are continually, systematically, and intentionally, denied this opportunity.

In the introduction to *Home Ground*, Lopez writes, “if we could speak more accurately, more evocatively, more familiarly about the physical places we occupy, perhaps we could

speak more penetratingly, more insightfully, more compassionately about the flaws in these various systems which, we regularly assert, we wish to address and make better” (xvi-xvii). Lopez’s words articulate a need for flexibility in our language and speech, a need to open ourselves to emotional — not just economic or intellectual — connection with our environments (whether man-made or not), and be receptive to being changed by and learning from them. Recall the phrases I referenced prior, “stone-hearted,” “a stony expression,” and “cold as stone,” that associate rock with a lack of feeling or compassion. A detached relationship with nature — one wherein it is to be separated from the “human,” studied, classified, and profited off of — was a staple of the 19<sup>th</sup>-century colonial period (Adams 22). This rhetoric, however, continues to shape human-environment relations as evidenced by extractivist policies continuously pushed forward by capital-motivated politicians (for example, see Snider 87).

In other words, the (il)logic of colonialism positions nature as separate from and secondary to the human, as only exploitable and expendable material. However, the specific example of the headstone as a site for familial care and attachment reveals the obfuscated and tangible network of affective relationships between humans and non-humans. To clarify, I do not mean to reduce the loss of loved ones into an intellectual exercise, but as an opportunity to develop a specific sensitivity to a form of human and non-human kinship. Through the emotion of grief and the practice of creating and caring for a grave marker, the deceased is no longer confined to the physical body, whose boundaries distort and blur. The human and non-human merge, become inseparable. Where do my grandparents end, and the stone begin? This, however, prompts a further question; what if the human and non-human are not so separate *to begin with*?

Scholars like Plumwood have already thoroughly discussed the formation and reinforcement of distinctions between human and nature (51-59), thus I will not do so here. What I want to linger on instead is the awareness of the entanglement of human and non-human facilitated by the stone grave marker, grief,

and rituals of care — what is the implication of this sensitivity for the human-nature relationship? In her 2018 article, Singh writes about a specific affect-informed “orientation” to the environment which she refers to as “affective political ecology” (2). She explains how this mode of thought enables an awareness of the world’s interconnectedness, a recognition of human society as “emergent” rather than independent of nature, and a rethinking of ecopolitics (2, 3). The reality is that in the face of a constantly worsening climate emergency, our individualistic nation-based political systems are ill-equipped to deal with a global crisis; “in both economics and governance, we individualise gains and socialise losses [sic]” (Dator 216). Drawing from Indigenous philosophy, Singh argues that unravelling the long-established assumption of the nature/human distinction can aid in reconceptualising conservation work as an emotional practice of love and care for both our human *and* non-human kin (3, 4). In short, if we can learn to attune to quotidian human-nature entanglements like those located on the grave marker, we may expand our practices of care beyond individual acts for immediate family, to collective action for all our kin.

In conclusion, throughout this article I explored dynamics of distinction, exclusion, and care as they play out across the site of my grandparents’ headstone. The seemingly rational distinction between wood and stone, and the prioritisation of permanency over temporariness is, in reality, highly contextually dependent, and informed by complex histories of class relations. In this article, I specifically discussed how in 19<sup>th</sup> century English, the lower and working classes were systematically consigned to a state of temporariness, to unmarked and shared graves. Thus, while transience becomes shameful, and a marker of failure, permanence and the conditions that facilitate it, such as the stone grave marker and privately owned cemetery plot, accumulate value. Despite the artificial nature of the superiority of permanence, it has been used as a criteria to denigrate other ways of being. Lastly, I pivoted to addressing the affective practice of care as it plays out in the site of the grave marker, where individuals care for a loved one through the non-human headstone,

thus merging the human and the non-human. Numerous other scholars like Todd, Bladow and Ladino, and Tsing have explored why affective kinship between humans and nature is crucial for on-going environmentalist efforts, how to foster it, and exactly *what* “care” can look like in these contexts. I have not even begun to cover the breadth and potential of affective ecology in this article. However, I hope to have inspired both a sensitivity to the constructed nature of taken-for-granted assumptions, and a curiosity towards practices of care that overflow with political potentiality. All in all, rocks are gneiss.

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## Interdisciplinary

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# Film in the Brain: Constructing a Cognitive Model for Context-sensitive Processing of Movies

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## Abstract

This review explores the field of neurocinematics, which highlights the power of cinematic techniques to direct viewers' brain states, and consequently their mental states, that is, their thoughts and emotions (Hasson et al., 2008). Editing styles and camera angles can contribute to completely different perceptual experiences of a movie, as evidenced by the Kuleshov experiment where viewers attributed different emotions to a neutral facial expression based on the preceding emotional scene (Cao et al., 2024). Through neurobiological studies on the Kuleshov effect, the underlying mechanism of this phenomenon was found to be 'context-sensitive processing', which can be considered a key concept in neurocinematics (Calbi et al., 2019). The context-sensitive perceptual experience is shaped by several cognitive processes. Firstly, research on mirror neurons has shown their involvement in using contextual cues to help viewers understand the intentions behind characters' actions. A chain of activation of logically related neurons then gives rise to embodied simulation through which viewers can attribute mental states to characters (Gallese, 2007). These mirroring processes alternate with mentalizing, which is a more sophisticated, conscious cognitive process arising in the prefrontal cortex that helps viewers imagine characters' perspectives (Ogawa & Shimada, 2016). Several other neurobiological and cognitive processes likely affect this interplay, such as event segmentation in the hippocampus where films are encoded in story arcs, possibly leading to more mirroring at the beginning of each arc to cope with lesser overt contextual information (Ben-Yakov & Henson, 2018). The review synthesizes these important concepts in neurocinematics literature to construct a preliminary cognitive model of context-sensitive processing that can provide directions for further interdisciplinary research.

Keywords and phrases: *Neurocinematics, Kuleshov effect, Context-sensitive processing, Mirror neuron system, Embodied simulation, Mentalizing*

## Introduction

Cinema as a medium can craft elaborate narratives for the audience by complexly engaging their minds. While this engagement has been extensively discussed at a mental level in film studies and cognitive sciences, the incorporation of neuroscience to produce neurocinematics research acknowledges the same complexity occurring at the underlying neurobiological level. Neurocinematics is an emerging interdisciplinary field utilizing modern neuroimaging methods to study how films are processed in the brain. This includes research on how a filmmaker's arsenal of cinematic techniques such as montages, continuity editing, and close-ups can be used to 'direct' viewers' brains (Hasson et al., 2008). These techniques make up the formal structure and aesthetics of a film and can be considered the core of a cinematic text, similar to language in a book (Hasson et al., 2008; Coëgnarts, 2017). The specifics of how movies are processed by their audience can therefore be understood through analysis of the effects of cinematic techniques on viewers, as they are central to the experience created by the

film.

The Kuleshov experiment is an example illustrating the influence of editing on viewers' emotional perception of faces. It demonstrated what is now known as the Kuleshov effect: when viewers were shown a neutral face, an emotional scene, then another neutral face, they attributed distinct emotions to the second neutral face based on the preceding emotional scene (Cao et al., 2024). Theoretical explanations for the Kuleshov effect hypothesized that either viewers perceive an entirely new emotional face, or there was context-dependent bias in their processing (Cao et al., 2024). With the growth of neurocinematics, the Kuleshov experiment was combined with functional magnetic resonance imaging (fMRI) or electroencephalography (EEG) in order to study brain activity. Data from Calbi et al. (2019) shows that the second neutral facial expression is still processed as neutral in the brain, meaning there is a lack of a distinctive perceptual experience. These results support the context-sensitivity theory instead, which implies the Kuleshov effect can be considered a cognitive process of applying expectations to the face that were formed by the con-

text (Calbi et al., 2019). In other words, the second neutral face defied contextual emotional expectations at the brain level, leading to the observer using these expectations to give the neutral face an emotional value at the behavioral level (Calbi et al., 2019).

Since context-sensitivity is central to processing a film based on narrative elements, it could be the key to combining the interdisciplinary literature within neurocinematics. This review therefore aims to construct a cognitive model of the context-sensitive processing in film-viewing by broadening the focus from identified neural correlates to associated cognitive theories. Combining these perspectives could provide a multi-dimensional understanding of our experience in watching films and the motivation behind film techniques. Addressing criticism of older literature, which employed static images in the experiment design, this study will utilize free-viewing, authentic film experiments involving actual film sequences (Cao et al., 2024). The free-viewing element, meaning participants simply watch video materials without being issued specific instructions or tasks, ensures that people's reactions to movies are studied in a more naturalistic, continuous environment instead of employing a series of discrete film clips (Ben-Yakov & Henson, 2018). This is in order to increase the generalisability of the study allowing application of conclusions to the actual film-viewing experiences readers might have. In summary, this review of neurocinematics literature will be used to identify key concepts in the field — from how we process a character's actions in individual sequences and develop a framework for their mental state over several sequences, to how the entire film is stored in our memory. These will be used to create a model illustrating how different aspects of cognition are involved in understanding the narrative of a film, as well as how the film's narrative elements contribute to the undertaking of these cognitive processes. Thus, we will highlight the context-sensitivity involved throughout the internal experience of a film's audience.

## Elements of Context Sensitive Processing

### Understanding Action Intention

The first element required in understanding a film is the cognitive process of action understanding, which helps viewers interpret what the character is doing in a film sequence without being explicitly told, similar to how we interpret people's actions in daily life. Action understanding refers to ascribing 'why' to an action, which at a neurobiological level is thought to occur through the mirror neuron system (Gallese, 2007). Mirror neurons are a special class of neurons that fire during both observation and execution of object-directed motor acts. Iacoboni et al. (2005) demonstrated that when shown three different scenes: (1) a context scene with only objects, (2) an action scene of a hand grasping a cup without any background objects and therefore no context, and (3) an intention scene with the grasping hand in either a drinking or cleaning context using differentially arranged background objects, there was a signal increase in brain regions where these hand actions are represented for the third intention condition. Hence, mirror neurons, which were originally characterized as simply action recognition neurons, dealing with 'what' the action is, were also shown to play a role in understanding intentions — 'why' the action is done (Gallese, 2007). For example, in a scene depicting a woman grasping an apple, the viewer recognizes what the character's action is by seeing the movement of her hand towards the apple. The viewer also recognizes that the character wants to grasp the apple, meaning her stimulus-linked goal or intention (Iacoboni et al., 2005). Thus, viewers form a rudimentary understanding of the story being told in each film sequence.

Another category of mirror neurons traditionally associated with execution of a motor act functionally related to an observed action were found to be visually triggered by the observed action itself. These are considered 'logically related' neurons (Iacoboni et al., 2005); observing the particular context of an observed action allows these neurons to code for motor acts most likely to follow based on what is typically carried out in that context (Gallese, 2007). These logically related mirror neurons participate in a chain of activa-

tion functionally involved in coding intentions for another person's motor acts. Single motor acts are connected in reaching a distal goal and thus participate in pre-wired intentional motor action chains, which allow the observer to predict the subsequent act and thus the overall distal goal (Gallese, 2007). For example, if the scene of the hand grasping an apple was preceded by a tower of apples, the viewer could infer that she was picking up this apple to stack with the others. However, in an example where the contextual scene includes a plate of sliced fruit, the viewer would predict the character's most logical motor schema to be them slicing and then eating the apple.

### Embodied simulation

The previously described chain of mirror neuron activation underpins the cognitive process of embodied simulation, through which the viewer takes the concrete nature of the visual image on screen and internally creates a more abstract, emotional schema (Coëgnarts, 2017). In other words, the viewer transforms their understanding of the character's actions into a mental depiction of the character's emotional experience. Embodied simulation describes how someone reuses their own mental and emotional states to functionally attribute those states to other people (Gallese & Guerra, 2022). It is because of such internal processes that films cannot be simply considered illustrations of the events or things they are composed of (Coëgnarts, 2017). The previously described scene of a hand picking up an apple is not just an illustration of the action; it provides visual cues that the viewer pieces together with other sequences to construct a wider emotional narrative within the movie. Film theorist Rudolf Arnheim has stated that in visual arts the artwork is the "strongest, purest, most precise embodiment of the meaning that, consciously or unconsciously, he [the artist] intends to convey" (Coëgnarts, 2017). In fact, the cognition perspective on cinema elucidates why films call for detailed analyses to pick apart all possible meanings, as every element of the audiovisual work, regardless of whether it was intended, has an effect on a viewer's perception of the work.

The explanatory role of audiovisual elements arises from their use as contextual cues in embodied simulation to grasp the meaning of the movie.

One example is the acting: characters' facial expressions are metonymic in nature, meaning they represent the characters' ongoing mental activity as a whole (Coëgnarts, 2017). Another dimension affecting perception is camera techniques and different types of editing imposed on the images in a film (Coëgnarts, 2017). For example, a close-up shot (Figure 1) where the camera is close to the subject and focused on their space intensifies the viewer's ability to mirror subtle emotions. This is achieved by limiting the amount of background visual information and forcing attention on the actor's face, thus magnifying minute changes in their facial expressions. The emphasis gives these scenes higher emotional weight within the film (Bordwell et al., 2020). Filmmakers therefore typically choose to use extreme close-ups sparingly for crucial emotional moments. In *Barbie* (2023), this type of framing helps mark a pivotal moment in the protagonist's exploration of the human world after she leaves 'Barbie Land' — the land of dolls. The viewer is directed to gaze at the actor's face as she portrays Barbie's complex reaction to witnessing the beauty and woe of aging for the first time.

On the other hand, a point-of-view (POV) shot (Figure 2) angles the camera to frame what the subject is seeing. In addition to providing information on characters' actions and speech, the filmmaker can incorporate POV shots for the viewer to be able to viscerally experience the subject's bodily sensations. Since this framing restricts provision of visual information to what the subject encounters, the viewer forms their understanding within the confines of the subject's unique perspective. Thus, there is a shift towards more subjective narration (Bordwell et al., 2020). In *Inglorious Basterds* (2009), this framing is used to punctuate the brutality of a running gag involving American soldiers marking their German adversaries with a swastika and even scalping some throughout the film. When Standartenführer Hans Landa is about to have a swastika carved into his forehead after switching sides at the end, the viewer feels an added sense of shock and fear despite already witnessing the act, since they finally see it from the target's perspective and thus live through the target's emotions.

The cognitive processes described above can together be called 'mirroring', defined as an automatic, unconscious, and pre-reflexive functional



Figure 1: Close-up shot from Greta Gerwig's 'Barbie' (2023)



Figure 2: POV shot from Quentin Tarantino's 'Inglourious Basterds' (2009)

mechanism arising from the mirror neuron system (Luyten & Fonagy, 2015). Mirroring helps create mental representations of agents and events. Thus, they play a crucial role in the topic of intersubjectivity, which entails an exchange of thoughts and emotions between subjects — such as the filmmaker and the viewer. Intersubjectivity is involved in understanding any art form (Coëgnarts, 2017). In cinema, mirroring facilitates intersubjectivity by helping the viewer 'put themselves in the character's shoes'. It helps develop an implicit sense of the film's narrative, even without much obvious exposition, through collation of the emotional schemas formed over the course of the film into a single conceptual domain (Coëgnarts, 2017). As previously described with embodied simulation, these schemas are made from what is described as contextual cues in cognitive sciences literature, and in the context of film studies these are the narrative elements of the film.

### Interplay of Mirroring and Mentalizing

However, mirroring is not the only method used to create the viewer's understanding of a

film as showcased by the involvement of mirroring in an experiment by Ogawa and Shimada (2016). They studied viewer's brains during a non-explanatory fictional film called 'Dolls', meaning actors showed minimal facial expressions and limited lingual information is conveyed (Ogawa & Shimada, 2016). The lack of these explanatory elements allows for a unique methodology to further investigate the viewer's internal experience: researchers can use non-explanatory films to study brain activation patterns during sequences that create an environment of uncertainty for viewers. It forces their active engagement as they utilize all possible cues to understand the sequence, and can highlight the differences between the effects of explicit and implicit narrative techniques. Towards the beginning of the Dolls film, participants of the study struggled to comprehend the narrative of the scenes and characters' behaviors. Due to the little verbal and non-verbal information provided, they speculated about the emotional and mental state of the main couple, which is substantiated by observed mirroring brain activity (Ogawa & Shimada, 2016). However, in later parts of the film, when participants had constructed a basic understanding of the characters through speculation, integrating the provided information, and simulating the narrative flow, a significant alteration in brain activity was detected (Ogawa & Shimada, 2016). Participants were now going through a more sophisticated cognitive process involving larger brain regions such as the medial prefrontal cortex, which is involved in higher-order functions such as decision making, reasoning, and social cognition (Ogawa & Shimada, 2016; Luyten & Fonagy, 2015). This willed and conscious cognitive effort is termed mentalizing, which interacts with mirroring to interpret the mentality behind overt behaviors of the characters (Luyten & Fonagy, 2015).

While both processes contribute to decoding the film, they are distinct in how they do so: mentalizing involves explicit cognitive elaboration of external information unlike mirroring, which is more experience-based (Gallese, 2005). The latter feels more effortless for the viewer because they use their own interpersonal experiences to decode others' experiences in the same social world (Gallese, 2005). The results of the 'Dolls' case study show that from a neuroscientific perspective, film is artfully structured to cause auto-

matic emotion processing and reflective inferential thinking in an alternating and complex manner by regulating how and how much information is provided (Ogawa & Shimada, 2016). The result of all these cognitive processes is the development of a formal unity and coherence for the filmmaker's work (Coëgnarts, 2017). In other words, viewers perceive a complete narrative from the series of scenes.

### Event Segmentation

While a film is perceived as one story, it is not stored this way in the brain as evidenced by event segmentation theory. The hippocampus, a crucial brain region for memory, is sensitive to 'event boundaries': time points that function as transitions between different events according to the viewer's perception (Ben-Yakov & Henson, 2018). This segmentation is driven by prediction error — failure to predict the immediate future, leading to a gap in continuity for the viewer. An individual event can therefore be characterized as having its constituent elements connected more cohesively than elements across different events, which affects the film's perception and memory consolidation (Ben-Yakov & Henson, 2018). This cohesion can be affected by an onslaught of new information. Media analysis shows that information often clusters at the beginning of a new section in the narrative. For example, in *The Godfather* (1972), the protagonist Michael Corleone is suddenly shown to be living in Sicily after killing two people, and we are introduced to a new character — a woman named Apollonia he wants to marry — leaving the viewer trying to catch up with the developments in his character arc. A protagonist's story is essentially about change, and such twists and turns are particularly important changes that can segment that story (Myers, 2022). The literary idea of story arcs thus fits in with how we mentally process the narrative in smaller events. It can be hypothesized that the beginning of each story arc involves more mirroring due to the lower amount of contextual information at that point in time. Thus, event segmentation could be associated with the interplay between mirroring and mentalizing, and deserves further research within neurocinematics.

Using existing research, we can construct a preliminary model showcasing the interactions

between different cognitive processes that contribute to the processing of film narratives (Figure 3). There is a bidirectional relation at play: different narrative elements — such as actors' expressions, framing techniques, and dialogue — are contextual cues that drive the cognitive processes involved in comprehending a movie, and these cognitive processes in turn contribute to the formation of a coherent narrative in the viewer's mind. Thus, the idea of narrative overlaps with the concept of context-sensitivity previously spotlighted by Calbi et al. (2019) using the Kuleshov effect. The model highlights that context-sensitivity is heavily involved in many aspects of cognition during film processing. At a cognitive level, it is through manipulation of the context provided, via cinematic techniques, that filmmakers tell unique stories.

### Conclusion

The objective of this review was to construct a preliminary cognitive model of context-sensitive processing of movies using existing research in neurocinematics (Figure 3). This concept was chosen as the keystone to aid the synthesis of literature due to its relevance in the mechanism underlying the Kuleshov effect, where the differential processing of neutral faces was shown to be due to context-dependent bias rather than a varying perceptual experience. Beginning with mirror neurons, given their significance in neurocinematics, leads to the first cognitive process included in the model: action understanding, which allows the viewer to understand the 'what' and 'why' of the character's actions. Through a chain of logically activated mirror neurons, the viewer is able to form expectations based on various cues that help them understand the character's long-term intention. The viewer then attributes their personal experience to the character to form an understanding of the character's mental state through embodied simulation. These two processes are together termed mirroring. Mirroring alternates with the more complex process of mentalizing, which arises from areas like the medial prefrontal cortex. Their interplay is influenced by provision of information in the film, and likely involves other cognitive processes like event segmentation in the hippocampus. Event segmentation shows the viewer

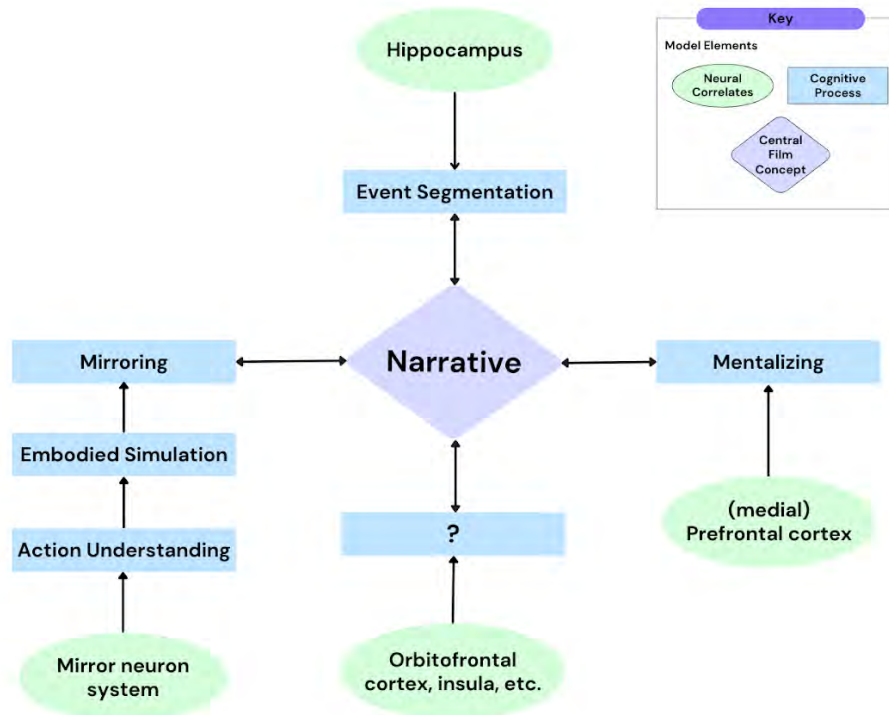


Figure 3: Preliminary cognitive model of context-sensitive processing of film

processes the film in story arcs due to prediction errors, and these could coincide with the shifts between mirroring and mentalizing. The narrative elements of a film contribute to the formation of a coherent narrative by driving these cognitive processes since they function as contextual cues. Thus, developing a model that showcases these interactions allows us to highlight the power of cinematic techniques over the audience, at both mental and neurobiological levels.

It is important to note the limitations in this synthesis to inform future research. Firstly, there is an inherent risk of reductionist views in neurocinematics since it generally involves simplifying human experiences into neurobiological mechanisms. Therefore, it is important to consider multiple disciplinary perspectives in order to investigate cinema through the sciences in an artistically valid manner (Ogawa & Shimada, 2016). The model itself is also somewhat reductionist, as there are elements of cognitive processing not taken into account. For example, cognition papers show that mentalizing can be broken down into several constructs such as mindfulness and Theory of Mind, which might play different roles within the processing of film (Luyten & Fonagy,

2015). However, this level of complexity has not yet been dealt with in current neurocinematics literature. The role of event segmentation in film perception also needs to be investigated further, particularly its relation to provision of narrative elements throughout a movie. Additionally, studying the involvement of regions recently implicated by Cao et al. (2024), such as the orbitofrontal cortex, insula, and fusiform gyrus, can help expand the neural correlates of movie processing.

Future research in neurocinematics is important for several disciplines. Advancements in knowledge could help filmmakers refine narrative techniques to create more compelling cinematic experiences. Neurocinematics can also aid our understanding of human cognition, as context-sensitivity falls within the broader concept of predictive processing, which refers to how humans constantly anticipate and adjust to incoming cues. Lastly, it has implications for neuroscience research as well since films are increasingly used in neuroscientific experimental paradigms. For example, trauma film paradigms are now used in post-traumatic stress disorder research to study intrusive symptoms (Hilberdink et al., 2022), and understanding how they are processed could in-

form the selection of films. Therefore, by bridging the gap in dialogue between film studies, cognitive science and neuroscience, neurocinematics can lead to significant advances in these fields.

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